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Land, Sea and Air Warfare

The Strong and the Weak in the Three Forms of Combat

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FROM immemorial time, man has lived and fought on two elements, land and water, and recently he has begun to use a third element—the air. Although all war has for its object victory as a means to a better peace, and although the general principles of military theory apply to every form of conflict, nevertheless every concrete case illustrating these principles must involve one or more of the elements on or in which every act of war takes place.

Each element or combination of elements requires different instruments and, to some extent, a different organization in order that the total armed effort may be effective. The instruments have this much in common that all are derived from the knowledge and wealth of the community which designs and manufactures or buys them; the power to produce wealth gives also the power to produce weapons, and every tool of peace, from the stone axe and the dugout canoe to the elaborate chemistry and metallurgy of today, is a potential weapon. But although all warlike instruments spring from a common source and are intended to serve the same end, nevertheless even the simplest are peculiarly adapted to the elements on or in which they are to be used so that all broad understanding of war must include analysis of the elements in relation to one another.

MAN is a land animal. Without elaborate apparatus he cannot navigate the air at all, and although he can learn to swim and has done so from the beginning of written record, yet his bodily powers of locomotion in the water are far less than on land, and to stay there too long kills him. The land produces all his food except fish and gives him all the materials for his tools, clothing and shelter, besides those for his water- and aircraft. Unless it be artificially distilled into freshness, he cannot even drink the salt water of the seas, but must drink fresh water from springs, streams and wells. His every sea and air voyage starts from the land, is supplied from the land, is intended to end there, and is undertaken in the hope of ultimately affecting land affairs.

On the other hand, water and air are important because each in its own way offers unique facilities for transport. The instruments of land transport are men, animals and vehicles; its characteristics are that the weight of the objects to be carried must always be supported on the earth's surface, while obstacles must often be negotiated. The simplest way for a man to carry objects is to pack them on his own back. Indeed a sort of civilization entirely dependent upon human porterage once existed in Mexico. All other civilizations however, and most communities which have raised themselves above the very lowest level of culture, have enjoyed animal transport. With animals as with men, the simplest means of carriage is in packs, but except Inca Peru which had only pack transportation by means of llamas, all known animal-using civilizations have economized the effort of their beasts by using them to draw wheeled vehicles. A man can easily push a light wheeled cart carrying five times the weight he could pack; in many cases he can manage ten times; indeed under exceptional conditions he might propel even more.

NINETEENTH-CENTURY Christendom developed a new mechanical source of power, the steam engine, which rendered vehicles independent of animals, enormously increased speed and power, and still provides—in connection with the railroad—the most economical form of land transport. The mention of railroads, however, reminds us that up to this point each increase in specialization and effectiveness had been gained by a sacrifice of flexibility. The earth's surface is seldom a firm, level plain; in its untamed state most of it presents many obstacles—vegetation, rock, sand, steep slopes, rivers, worst of all—marsh. On the whole, a man with a properly designed pack can work his way over or through more of these obstacles than any pack animal, although many minor obstacles to which riding or pack animals are indifferent nevertheless cut down the speed of footmen very seriously.

When we come to wheeled vehicles the loss in flexibility is striking; although historically the vehicle must have antedated the road, and is never rigidly confined to it, yet outside of South Africa and the United States west of the Mississippi, few large districts will take wheels effectively except on regular road systems, supplemented by ferries or bridges, causeways over marsh, etc., and everywhere the effectiveness of vehicles is greatly increased by roads. Now the cost of making and maintaining roads is considerable, and often it is very high indeed. Without a road, wheeled vehicles are helpless before many obstacles negotiable by pack transport, and no normal team of animals can pull heavy loads up slopes of more than one in fourteen, whereas pack transport can easily manage grades of one in eight under good conditions—unless it be by camels which when loaded can

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do no better than one in ten. In most roadless areas, the usefulness of wheeled vehicles falls off rapidly and in many it approaches zero.

The steam railroad carries both specialization and inflexibility to their highest point; notwithstanding its great speed and power on a flat straightaway, it will take only the gentlest curves, will hardly manage slopes of one in thirty, and even with special engines will not climb grades of more than one in twenty, while its peculiar rolling stock is absolutely useless except on rails which must be in perfect alignment. Our own century has developed the internal combustion engine and has adapted it as a motor to wheeled vehicles equal to the railroad in speed and far superior to it in flexibility. Such vehicles are independent of rails, are able to take slopes of one in five, sometimes even steeper, and are even capable of moving across country—although with less obstacle-negotiating power than that of animal-drawn carts and wagons.

Still more recently, the wheels of motor vehicles have been supplemented by the caterpillar track, thus combining great effectiveness with astonishing flexibility. On the debit side, tracked vehicles are somewhat slower and less economical than ordinary automobiles and motor trucks operating on smooth, firm and flat surfaces, and are therefore considerably less efficient than the ultraspecialized railroad. But on the credit side, already their speed is approaching that of wheeled motor vehicles, and greatly exceeds that of any animal, while they are independent of roads and can negotiate many sorts of obstacles better than any other land transport. Tractors have even been made amphibious, *i. e.,* capable of movement on land and of floating and maneuvering in deep water as well.

TURNING now from land to water, the universal instrument of water transport is the ship or boat, and its characteristic is that the weight of ship and cargo is carried by the liquid element which is comparatively free of obstacles as compared with the land. In a canoe or rowboat, a single man can easily move bulky or heavy loads which he could not possibly lift or carry. In larger boats under good conditions, he can propel a hundred times his pack-load, and with a specially designed sailboat can manage a load several hundred times greater. Moreover the support of weight by the water permits great extension in size. As the great whales exceed all land creatures, so practicable ships can be built much larger than any single land vehicle. A limit to size is set by the depth of water in which the ship is to be used; an ocean-going ship's draft must be a certain proportion of her other dimensions—if it be reduced below that proportion she will become unseaworthy. Moreover a very deep draft forbids the use of most harbors. Thus, one reason why the British, under Lord Fisher, began building very large battleships of the dreadnaught type, was because their rivals, the Germans, did not possess harbors deep enough to take such monsters; another consideration was that the Germans would not be able to afford so expensive a type. But in the event the Germans found the money and dredged their harbors deeper.

Another restriction on size is difficulty of handling; other things being equal, a larger ship is clumsier than a smaller one in anchoring and getting under way—still more so in working up to and away from a dock. Thus about the middle of the nineteenth century the introduction of the steam tug made it desirable to increase the size of ocean-going sailing ships beyond what had previously been considered the economical size. Within the last generation there has appeared a tendency to go on increasing the size of battleships where that size is not limited either by international agreement or by the dimensions of canals through which the ships must pass. In the case of luxurious liners which are to combine speed, comfort and ostentation, a similar tendency still exists. But in the cargo carrier the limitation is fixed chiefly by the customs of the trade for which she is built, and it does not pay to build her so large as to lessen her chance of a full cargo.

Although in good weather ships can anchor in any water which is neither too shallow nor too deep and is possessed of a suitable bottom, nevertheless their security is greatly increased by the use of sheltered harbors in which they can anchor or moor to rest their crews, take in supplies, and embark or disembark passengers or cargo. Ships driven by engines must also take on fuel at regular intervals. Finally, although at much longer intervals, ships must be docked and their bottoms cleaned—else they must suffer loss of efficiency through fouling. Finally any serious injury must be repaired in harbor, and if the injury be below the water line, the ship must go into dry dock.

After all her limitations have been duly considered, however, the ship has great advantages over land transport. In addition to the navigable rivers, some four-fifths of the globe is covered by the ocean. Over this vast area the ship is independent of artificially made ways; she goes where she likes. Her usefulness may be increased by canals or dredged channels, but even without them her field of action is far greater than that of land transport in any or all of its forms. Historically, water transport usually precedes land transport both for exploration and in the development of new countries; the coasts of the Americas, Africa and Australia were fairly well known centuries before their interiors had been mapped. James Truslow Adams' "Founding of New England" tells us that not until 1722, almost a century after the founding of Connecticut and Rhode Island, was the first vehicle driven overland between the two states. Again water transport has the enormous advantage of cheapness. The same work just cited says that in the eighteenth century freight rates by water along the Hudson river were only one-sixth of rates for the same distance by land. Even today, freight can be transported by water at not much more than half the sum necessary to transport it from New York to San Francisco by rail. Moreover the average freighter can make the trip through the Panama Canal in only twice the time usually required to move goods across the continent in a freight train.

FROM the foregoing analysis, if we neglect the air for a moment, we may now turn to the interaction of land and sea forces in war. Within gunshot of the coast the two may directly affect each other by bombardment. When the wealth, civilization and equipment of the combatant groups are at all equal, fire from the shore is more dangerous to ships than vice versa because the ships offer better targets than well-designed shore batteries. Consequently an increase in the range of guns diminishes the power of a fleet in narrow waters; for instance, in Napoleon's time the British fleet alone could keep superior French land forces from crossing the Channel, whereas today long-range artillery would figure both in covering and opposing such an operation. Leaving aircraft out of account, and assuming overwhelming superior-

ity in the attacking artillery, such artillery could do much to cover the entire crossing. Most combats however, are either far enough inland or far enough out to sea to be independent of fire from the other element; thus in general, fleets oppose fleets and armies armies.

An army can blockade an enemy insofar as it can cut his land communications; or it can assault him, and if successful can compel submission by occupying his territory. A fleet, on the other hand, cannot assault hostile territory but can blockade by cutting the enemy's sea communications, at the same time making such communications available to its own side. Thus a superior fleet can prevent hostile assault from overseas, or can add to the assaulting power of friendly land troops by carrying or convoying them across the oceans.

The importance of land versus sea power is entirely relative, depending upon the geographical position of the combatant groups. Between antagonists with a common land frontier and little overseas traffic, sea power hardly comes into play at all. To an island state on the other hand, sea power obviously makes an enormous difference; if the insular population lives by overseas trade, most of all by imported food, then strength at sea is their one alternative to surrender. Possessing such strength, they are secure against assault and can usually protect the sea-borne trade by which they live; without it they are liable to the cutting of their sea communications, and also to assault if their enemy considers blockade not enough.

Another factor entering into the relative importance of land and sea power is that of time. If two combatant groups have a common land frontier, while at the same time both possess a considerable overseas trade, then a quick decision on land will prevent sea power coming into play, whereas a delayed land decision will permit sea power to act. For instance, had the United States Federal government in 1861 been able quickly to reduce the Southern Confederacy by land assault, sea power would have played no part. The naval blockade by the Federals became important only because the war on land was prolonged. Another instance is the Franco-Prussian War of 1870-1871: when nearly all the French regular soldiers were quickly put out of action, the superior French sea power had no chance to make itself felt. In 1914 had the Allied armies quickly destroyed the German army, peace would have been forced upon Germany without the aid of Allied sea power.

AN effective blockade not only requires time but also a blockaded area vulnerable to the cutting of its sea communications. As today with an active overseas trade, so in the war of 1914-1918 a prompt German victory over Russia would have made the area subject to the Germans far less vulnerable to the British blockade than it actually was. There would still have been a shortage of tropical products, especially rubber, but Rumania and the Caspian region would have furnished oil, while Poland and South Russia would have provided food. In the event, the collapse of Russia came only after the Germans were already so pinched by blockade that only a quick decision in the west could have saved them.

Another variable in naval warfare is the effectiveness of sporadic sea warfare against the group possessing the superior fleet. A successful army can occupy a district and administer it as absolutely as a legitimate government—although of course more expensively than such a government. But even in the old presubmarine naval wars the superior fleet could never prevent considerable numbers of single ships, often small squadrons, of the weaker side from getting to sea. We may instance the French privateers during the wars of Louis XIV and Louis XV against England; the American commerce destroyers of 1775-1783 and 1812-1815, together with the Southern commerce destroyers of 1861-1864. Obviously the submarine has greatly increased the opportunities for sporadic warfare against a combatant whose surface fleet is the stronger. By increasing their flotillas of small craft and by convoying merchant ships, the Allies were able to preserve their essential sea communications, but only with difficulty.

Sea power has been peculiarly important throughout modern history; indeed the modern period may be said to open with the beginning of transoceanic navigation. As early as the sixteenth century Sir Francis Bacon in his essay "Of the Greatness of Kingdoms and Estates" wrote: "He that commands the sea is at great liberty and can take as much or as little of the war as he will." Although the saying was made with England in mind, it applies to all wars in which there is no common land frontier. By the middle seventeenth century, oceanic trade had long been so important a source of wealth that the English poet Marvell, celebrating the victory of Cromwell's Admiral Blake over the Spanish treasure fleet at Santa Cruz, could write:

> "Oh would those treasures which both Indies have
> Were buried in as large and deep a grave;
> War's chief support with them would buried be,
> And the land owe her peace unto the sea."

If we confine ourselves to the principal wars since 1700 we find nearly all of them involving important naval operations and not a few turning altogether on sea power. Within the last forty years, the Spanish-American War was chiefly naval. Although the South African War was fought exclusively on land, nevertheless England could not have subdued the Boer Republics had her sea communications been subject to interruption. In the Russo-Japanese War, only superiority at sea permitted the Japanese to invade Korea and Manchuria; had Russia succeeded in cutting their sea communications they must have surrendered. In the Italian-Turkish War of 1911, the Italians, thanks to their sea power, were able to transport their land forces to invade the overseas Turkish province of Tripoli which the Turks were correspondingly unable to reënforce. The influence of sea power in 1914-1918 has already been touched upon.

The Russo-Polish War of 1920 is an anomalous case: it was fought on land, but since Soviet Russia was then almost entirely cut off from international intercourse whereas Poland was not, and since the latter could communicate with the outer world by sea, the Poles therefore enjoyed something of the advantages usually conferred by naval superiority. The only recent instances of wars decided wholly by land operations irrespective of ability to use the sea, were the Balkan wars of 1912 and 1913, in both of which—as in the Prussian wars of the middle nineteenth century—the success of the victors by land was rapid and decisive.

NEVER before in history has the ordinary standard of living among civilized peoples been so dependent upon international exchange and overseas trade. Of the world's seven

great powers, Britain and Japan are islands. The United States has only weak land neighbors; even if Canada be considered as a single power with Britain, still the latter has only a small army. Accordingly any important international war waged either by Britain, Japan or the United States must involve naval operations. France and Italy have considerable coast lines and important fleets, leaving Russia as the only great state whose national strategy is almost entirely terrestrial rather than maritime. The case of Germany is exceptional: for the moment she is weaker by sea than by land but it is not certain how long she will be so.

On the other hand it is possible to exaggerate the importance of sea power. In the successful English wars against the French Bourbons, the French Revolution and Napoleon, victory was gained only when the French naval effort was diminished by France's necessity to make war on land at the same time. In the closing phase of the American Revolution, France achieved her object—American independence—chiefly because she was not compelled to fight on land in Europe. In the capital cases of the English war against Napoleon and during 1914-1918, although sea power was an important factor, nevertheless it is not easy to decide just how great was its importance. Indeed, without superiority at sea, the British could not have resisted Napoleon at all; he would have thrown his superior army into England and all would have been over. Again, without sea power Britain could neither have supported the Spanish insurrection, nor could she have exercised against Napoleon and his continental allies that economic pressure which led to his quarrel with Russia and his decisive failure in that country in 1812. On the other hand, Napoleon's economic position was strong; had he succeeded in Russia he might well have outlasted England. Moreover, England must inevitably have gone under in the long run had the vast Napoleonic empire been granted a period of peace in which to build up its potentially overwhelming sea power.

To say that Napoleon must necessarily have failed in Russia is to read history backward; at the outset the chances were in his favor rather than against him. Napoleon might have proclaimed Polish independence. He might have put the Russian forces out of action in June or July. In August he might still have halted at Smolensk, whence he could have put far more pressure upon the Russians than they upon him. Finally he might have destroyed the Russian army at Borodino. Turning to 1914-1918, we have already seen that the Allied sea power had its chance only because the Allied land forces failed to put the German army promptly out of action. Nor is it necessary to enlarge on what might have happened had the Germans taken the Channel ports, as they came so near doing in 1914 and again in the spring of 1918. In other words, sea power by no means guarantees success against superior land power.

CONTROL of sea communications by a superior surface fleet—never absolute, for even in the old wars single ships and often small squadrons of the weaker side could always get to sea—has recently been further restricted by the submarine and the plane. Nevertheless surface ships remain much the most important factor both in peace and war. Compared with their ability to carry passengers and cargo, that of submarines and planes is very slight. Nor does either new instrument promise to replace the surface ship as the principal factor in naval war. The submarine has indeed proved able to interfere with hostile—or neutral—traffic, and the plane is capable of something of the same sort, but neither by itself possesses any appreciable power of protecting friendly traffic. The comparatively slight endurance of both will tend to limit their effectiveness chiefly to coastal waters within a few hundred miles of some base, and even within these zones a surface fleet has considerable powers of reaction against both. To the powers and limitations of the plane we shall come in a moment. The submarine can never have either the endurance or the fighting power of surface ships anything like her equal in tonnage. In 1914-1918 the Allied surface fleets which had completely swept German commerce from the high seas, reacted successfully against the German submarine campaign; in spite of their slowness in adopting the convoy system and other antisubmarine devices, they were able to keep their own sea-borne commerce moving.

Within a generation, man has gained the power of using a third element—the air—and obviously air navigation must greatly affect human activities both in peace and war. The question is, how greatly? That question however cannot be answered certainly, because air navigation is so new. If we know the geographical situation and resources of two combatants we can estimate closely the relative effect of land and sea power in a contest between them, but enormous differences of opinion exist as to the part to be played by the air. Some believe air fleets are destined to dominate future strategy, making the older arms mere auxiliaries, while others think the inherent limitations of aircraft will permanently limit them to an auxiliary rôle. In this dilemma we can only examine the characteristics of aircraft and their achievement in war up to the present time. From such data, together with knowledge of the technical improvements made since 1918, we can form an opinion as to the value of air power relative to the older arms.

The effect of novelty upon opinion in general is two-edged. People have sometimes minimized the effect of a new device because they lacked imagination and were too much bound by habit and routine, while others are carried away by novelty and will exaggerate the power of some new instrument merely because it is new.

WHILE the land, on which man chiefly lives, covers about one-fifth of the globe, and the sea the remaining four-fifths, the entire planet is enveloped by air. Thus aircraft in flight can pass indifferently over land and sea; within the lower limit of land and sea surfaces and their upper limit or "ceiling" —that is, the height above sea level which the individual plane or airship can reach—together with the horizontal limit of their flying range, they can go where they like. Moreover planes can travel at enormous speed, 100 miles an hour is moderate, about 200 is not uncommon, and over 400 has been reached.

The limitations of aircraft resemble those of ships together with other limiting conditions imposed by the nature of the air itself. They must be based upon the land, or else upon a ship as small boats are, and to their base they must return for the repose of their crews, for repairs, shelter and supplies —most of all for fuel. Without refueling, a plane cannot remain in the air much longer than a day and a night; thus its radius, however great in point of space, is sharply limited in time. Furthermore, planes are affected even more than ships

by obstructions to visibility, fog, snow, or heavy rains, with the additional danger that no matter how poor the visibility, a plane must keep up its speed or suffer disaster. Nor can a plane or a dirigible be at all certain of its position when out of sight of the sun or of some well-known landmark, because in flight the force of the wind and the subsequent wind-drift cannot be accurately known—the only wind felt is that caused by the speed of the flying object through the air, irrespective of how the latter may be moving. The amount of cargo or surplus weight of any kind which can be carried is extremely small, almost negligibly small compared with the cost of aircraft. Thus a large bombing plane which will cost over $60,000, with its fuel and crew will weigh about 6½ tons and will carry a weight of guns, ammunition and bombs—corresponding in commercial planes to a "pay load" of passengers or cargo—of only 1½ tons. Finally, although planes in flight have little to fear from obstacles, nevertheless they require a considerable space of either level ground or smooth water from which to take off and on which to alight. Flying and especially landing "blind" is enormously hazardous. Autogiros can land at a much steeper angle than an ordinary plane, but this facility is purchased by a considerable loss of speed.

The record of aircraft in war is confined to 1914-1918 together with the lesser military operations since the Armistice. The military record of dirigible balloons may be quickly passed over: before 1914 the German navy hoped for much from them but during the actual naval operations only one important report from the Zeppelins seems to have been received, and this, on August 19, 1916, was entirely misleading. In the early years of the war the Germans also used Zeppelins as bombers but gave them up in favor of the planes. And today no one maintains that the military uses of dirigibles will equal those of planes. As with the dirigibles, the first military use of the plane was for reconnaissance, to which was soon added the duty of spotting for long-range artillery fire. Reconnaissance was developed into the taking of elaborate air photographs of hostile positions. The power of attack upon ground objectives both by machine gunning, known as "ground strafing", and by bombing was next achieved. Bombing was used both against military objectives and against nonmilitary ones, *i. e.,* hostile cities.

BUT when we come to ask how far all these air activities contributed to the victory of 1918, the answer is very doubtful. During the battles of 1914 not a single important result can be claimed for air reconnaissance. The same is true for the long period of trench warfare; the most elaborate air photographs did little to facilitate the conquest of the positions photographed. The Allied air forces failed to observe the preparations for any of the four main German offensives of 1918; on the first three occasions, mist prevented their seeing the assaulting troops during the actual attack, and they proved unable to halt or delay the German advances after each breakthrough. On August 8, 1918, when the British attacked east of Amiens, German airmen brought down no less than 83 British planes behind the German lines with slight loss to themselves, and yet the day was disastrous for the German ground forces. Absence of air support did not slow down the American advance at St. Mihiel, nor did its presence noticeably speed up that in the Argonne. Toward the end of 1918 it is said that air work completed the disorganization of the retreating and demoralized Bulgarian and Austrian armies. But it seems reasonably certain that the surrender of those armies would not in any case have been long delayed.

Since the Armistice, France has used planes in Morocco and Syria; England in Irak and on the Northwest Frontier of India; the United States in Nicaragua; Japan in China, Shanghai and Manchuria; and Italy in Ethiopia. In Syria the French air work did more harm than good, irritating the rebels without terrifying or subduing them; in Morocco, planes proved useful auxiliaries to ground troops but only to a limited extent. The same was true on the Indian Frontier where the attempt to terrify the tribesmen by bombing their villages failed. In Nicaragua, planes did good service in communication and reconnaissance, but only once—at Ocotal—were they able to attack troops effectively, and be it noted that even there the casualties inflicted are known only from the necessarily imperfect estimates of the aviators themselves. The Japanese bombing of the Chinese city of Shanghai was of little or no advantage to the Japanese ground troops. In Manchuria, Japanese planes bombed and machine-gunned the ill-equipped and loosely organized Chinese troops on a number of occasions, for instance at Harbin in January 1932, but to put the matter conservatively, it does not appear that they accomplished much more than could have been done by a far less expensive force of good light cavalry.

Before the Italian campaign in Ethiopia, the one definite success of air bombing was in Irak where the local Arabs—neither very formidable nor determined fighters—depend upon flocks and herds which can easily be scattered from the air. The costly and considerable Italian air effort against the Ethiopians has undoubtedly had its effect, but we must wait for full data before judging how great that effect has been. Alike in reconnaissance, in transport and in attack against the enemy on the ground, the Italians have used planes on a far greater scale than any other army on active service since 1918. Although the Ethiopians have had practically no planes and almost no antiaircraft guns, previous to their collapse the accounts of the effectiveness of air attack against civilians or ground forces varied greatly: the Ethiopians belittled that effect while the Italians estimated it highly. A just estimate will be possible only after careful comparison of the conflicting statements.

INASMUCH as confidence in the military value of dirigible balloons is now so nearly nonexistent, we may concentrate on the characteristic limitations of planes. In the first place, a plane cannot occupy territory. Nor can numbers of them blockade an area as ships can; they can circle about in the air but their limited time of flight soon forces them down. Moreover since they cannot land safely in bad weather or whenever visibility is bad, it is suicidal for them to take the air under such conditions. They can protect or help to protect their land or ship bases only when in the air; when on the ground or on a ship's deck their fighting value is nil. Moreover maximum effectiveness is obtained only after reaching a certain altitude, which demands a time interval varying with the speed and the angle at which the plane can climb.

An amusing but instructive example of the dependence of planes on bases was furnished by the revolt of the Chilean air corps in September 1932. Lacking ground troops to protect their air field, the rebel aviators were bloodlessly and ignominiously overcome by infantry attack while on the ground.

Besides the necessity for each individual plane to have a flat, firm surface of reasonable size upon which to land safely, the size of the available air field also determines the time within which a squadron of planes can land or take the air—the smaller the field the greater the time required.

The airplane bomb is an essentially inaccurate weapon as compared with the gun, because the gunner can correct his aim after seeing his projectile strike, whereas the bomber, in order to hit his target, must navigate his plane to a single spot in space over that target and cannot correct subsequent shots from a first error. There is also the speed of the wind to be considered, and we have seen that the aviator has no means of determining this, since the only wind he can feel is that caused by his own speed through the air. Obviously the importance of this wind factor increases with the height of the plane above its target. Height in turn is affected by the antiaircraft guns of the defense: up to an altitude of about two thousand yards planes are in the greatest danger from antiaircraft machine guns, while the larger antiaircraft pieces can burst their shells accurately at nearly seven thousand yards up. An aviator can indeed make himself a more difficult target by dodging about, but in that case he himself can count on hitting only the most enormous targets with his bombs: to bomb accurately by using bomb sights necessitates flying in a straight line, and this in turn gives the antiaircraft gunners a promising target.

Whatever one thinks of the future effectiveness of antiaircraft gunnery, no one can deny the astonishing improvement of antiaircraft fire directors since 1918, an improvement out of all proportion to the corresponding improvement of planes. Besides the older method of bombing from a height with the use of bomb sights, a new method known as dive-bombing has been practiced: having located his target while still in the air, the aviator dives directly for it, releasing his bomb when very close, and then levels out in order to escape. This reduces to a minimum the time within which the defending antiaircraft gunners can fire at the plane before it drops its bomb. The method would seem more applicable to the bombing of ships than to land warfare, for on land a target small enough to necessitate dive-bombing and also valuable enough to warrant airplane attack, would usually be either screened from view—by a smoke screen when natural cover was not available—or would be provided with some form of overhead protection. Obviously the design and construction of overhead protection for fighting ships and important ground objectives is capable of considerable development.

THE use of air reconnaissance in naval warfare is limited by the inability of aircraft to determine their exact position when out of sight of their base ship or of some known point of land. Further, weather conditions interfere more with aircraft than with any other sort of reconnaissance. Under certain atmospheric conditions aircraft cannot see as well as surface craft, nor can they navigate as close to a line as surface craft. Finally the great speed of planes, together with their inability to stand still in the air, prevents them from patrolling an area for any length of time except in such great numbers as to represent a prohibitive expenditure of money and effort, whereas a comparatively few surface ships or submarines could do the job as effectively and far more cheaply.

In actual practice the effectiveness or ineffectiveness of aircraft in naval combat as compared with the gun remains to be demonstrated. While the sinking or disablement of a hostile ship would be worth the loss of many planes, still the plane is merely a "supermarine" torpedo boat, and so far the torpedo—notwithstanding the vast claims made for it forty and fifty years ago—has never come anywhere near displacing the gun as the chief naval weapon. In proportion as air bombing is feared, future naval engagements seem likely to begin with attempts by the planes of each side to sink or disable the aircraft-carrying ships of the other. The use of airplane spotting for long-range gunnery will probably be less important than air reconnaissance and air bombing. Should one side fear air spotting there seems no reason why they should not use their radio apparatus or wireless to jam the radio or wireless of the spotting planes.

Airplane spotting on land would be subject to the same difficulties as at sea. Even under the best conditions air spotting cannot possibly equal that done by an observer who is on the ground and connected by telephone with the guns. That the Germans recognized the importance of ground spotting as compared with air spotting is shown by the pains they took to site their Hindenburg lines so as to make ground observations of them difficult. Although no one would deny the value of air reconnaissance on land, nevertheless army maneuvers since 1918 have shown it to be not only impossible or valueless under many conditions of weather and terrain but also highly inaccurate in detail. An observer rushing about in the air at a hundred or more miles an hour is not in the best position to distinguish, for instance, a tank from an artillery tractor—a mistake frequently noted in postwar British maneuvers. Moreover air reconnaissance even by day under the best weather conditions can get "negative information"—information that the enemy is not in a given area—only under the exceptional conditions of absolutely flat, bare and open country; woods or buildings are impenetrable to it. The repeated German successes in producing strategic surprises during March, April and May, 1918, show that the most diligent air scouting may be altogether ineffective. So far, air action against ground troops has never shown decisive results on any scale, and has frequently failed to be worth the cost and effort involved.

To sum up: in combats between ground troops, planes are very useful auxiliaries. Within flying range of well-equipped bases they are capable of great speed and are unimpeded by ground obstacles. Accordingly they may often achieve results impossible to light cavalry or fast, mechanized forces. On the other hand they are weapons of opportunity, subject to many limitations from which the ground arms are free and—to speak in terms of the old wars—they may be considered as a sort of superlight cavalry.

INTERPRETING the term "coastal operations" in its widest sense, perhaps the greatest effect of the plane upon strategy will be found in them. First: planes should considerably reduce the ability of a surface fleet to approach a hostile coast. Since the number of planes which can be carried on and launched from ships is strictly limited, any moderately well equipped power should have great superiority of numbers in the seas within flying radius (that is within half the flying distance) of its shores. Thus in a sense, the defending planes may be considered as coast-defense guns of enormously increased range. Outside of flying radius of the shore, obvi-

ously only planes based on ships will be available to either side. Second: within flying radius either seaward or inland from a coast, planes are interchangeable between sea and land warfare. All the land planes which have been serving as auxiliaries of the army could be suddenly thrown in to support the planes of the fleet and the surface ships when the latter were attempting some particular operation. In the same way the naval planes could be suddenly massed and thrown in to support the army. If we ask how far such a sudden shift might tilt the strategic balance, we are thrown back upon the unsolved problem of the value of planes in combat. At any rate the possibility of such air concentrations in aid of either land or sea forces helps us to think of all strategy, naval or military, as one; which is as it should be.

The widest difference of opinion as to the value of planes in future war is found when estimating the possible effect of airplane bombing raids on cities. A very vocal school of thought has succeeded in impressing the public mind with the idea that such raids might very quickly decide a war. On the other hand most of those who have seriously studied war believe nothing of the sort. Although our limited experience necessitates caution, nevertheless that experience—together with knowledge of the relative improvements made since 1918 in both planes and antiaircraft devices—indicates the indecisiveness of air raiding. To say this is to oppose public opinion; to see the matter clearly it is necessary to concentrate on the facts. Between 1914 and 1918 the material damage done by air raiding was practically nil in comparison to the air effort. The Germans raided Great Britain over a hundred times, dropping about 9000 bombs, aggregating about 280 tons, which killed only 1413 persons (about the same number as those killed in motor accidents in New York City during the single year 1928) and injured an additional 3408. No nation was put out of action by air bombing; no city was ever paralyzed; apparently not a single city block was ever demolished; only one bridge—in Turkey—appears to have been destroyed. Whether the bombers were Allies or Germans the results were the same.

There was indeed a certain slowing up of factory production immediately after a raid; for a day or two production in some British munition factories fell off fifty per cent. Moreover the air raiders, like the commerce destroyers of the old naval wars, achieved a certain diversionary effect. Just as the British in those old wars had to divert considerable forces from their battle fleets in order to protect their merchantmen against French sea raiders, so both Allied and German higher commands found it necessary to divert considerable air forces from front-line service in order to protect their cities against bombing raids. For every Allied plane bombing the Rhineland, the Germans detached about two protective planes; for every German plane threatening Britain, the British held back more than five. The reason for these detachments was the moral effect of the bombing, the fright and annoyance among the populations, which all agree was out of all proportion to the actual damage. Just how important the moral effect was, no one can say. Some Londoners maintain that a moderate increase in the moral strain would have disorganized the corporate life of the city; others insist that most of the city dwellers soon became accustomed to the raids and took them philosophically.

In estimating the future, those who hope for decisive results through bombing cities, although they must admit the insignificant results achieved in 1914-1918 and in the small wars since that time, still believe the improvement of planes and their increase in number will accomplish considerable results. The improvement in bombers and potential bombers however, hardly supports this claim. We must remember that in such matters it is the performance of the average plane which counts; a few exceptional machines of extraordinary range, speed and carrying power would affect matters little. In general, the day bomber of today carries about the same weight of bombs as the good machines of 1918 and has an effective radius about fifty per cent greater. Few night bombers can carry more than a ton of bombs further than 300 miles if they are to return. Again the weight is the same as in 1918 although the radius is greater.

THE increase in the number of civilian planes convertible into bombers is important only to the extent that pilots with some real military training could be found to fly them; if enthusiastic civilians tried to play the part of "air guerillas" their navigational and military casualties would be very heavy, doubtless prohibitively so. Far more civilian pilots could be trained well enough to take part in defensive flying than would possess navigational skill sufficient to fly great distances at night, locate a darkened hostile city, bomb it, and return. Accordingly the increased number of civilian planes would not favor bombing attacks so much as might be supposed. The dropping or spraying of poison gas from planes is of very doubtful value; practically no qualified authority believes in its effectiveness.

Finally we must consider the improvement in measures for both active and passive defense. Practically all bombers or potential bombers are still vulnerable in war-time to the fighting planes of the defense, and the activity of these defensive fighters can be better coördinated than in 1918, thanks to the new sound locators together with radio communication between the defensive ground organization and the defending planes. Such radio communication is particularly important because it is much easier to see a plane from the ground than from another plane in the air. The great improvement in antiaircraft gunnery cannot be denied. Passive defense, the provision of shelters, respirators, etc., together with plans for evacuating into the country the surplus populations of threatened cities, have all been considerably developed. To the grave political disadvantages of air "frightfulness", or of any military method which increases the cruelties of war, we shall come presently. Concentrating for the moment on purely technical aspects of bombing cities, let us sum up the chances. The war-time German raids on Britain killed only 1413 people. Weighting the argument very generously in favor of the bombers, let us assume that in spite of the improvements in defense, four or even five times as much as before could be accomplished. Does anyone believe for a moment that raids which kill 5600 or 7000 English men, women and children would either disorganize Britain's national life or compel her government to surrender and sue for peace? Even with a multiple of ten, resulting in 14,000 deaths, such a decision could hardly be expected.

ANOTHER idea requiring drastic correction is the current fallacy that the one possible and effective defense against the bombing of cities is retaliation in kind. In the first place, retaliation is not a defense at all. Further, human nature

being what it is, if cities are bombed, public opinion will forbid concentrating on retaliation and will compel the government to make real defensive efforts. We may compare the clamor raised by the people of the English east-coast towns when these were bombarded by German warships: no one with the smallest knowledge of mankind will be astonished to learn that they considered the matter in an intensely personal light. Nor were their protests ineffective; the dispositions of the British fleet were considerably modified because of them. It would have comforted the protesters little to be told that German ports were being similarly bombarded. In addition to direct defense, there is no reason why the planes of the country attacked should not in their turn attack the airdromes and ground organization of the hostile bombers. So in the old wars, the British used to attack the ports which served as bases for French commerce destroyers, and so in the war against Germany they tried to block Zeebrugge because it was a submarine base. If indeed the ground cannot defend itself from the air, then the ground organization of the hostile air force cannot do so.

BESIDES the technical questions involved, the proposed bombing of cities from the air also raises grave political questions. The inaccuracy of the airplane bomb makes it an undiscriminating weapon—even if the aviator is trying hard to hit a definite, military target he may fail to do so. If he is bombing such a target in a city, the chances of his unintentionally hitting a nonmilitary target are considerable; when he is bombing a city to spread terror among the population then nonmilitary targets are his avowed objectives. In this connection it is instructive to note that in 1914-1918, although both sides knew that hostile bombs fell more or less indiscriminately upon their own cities, both believed that their own aviators were careful to attack only true military objectives. Without discussing how far factories, together with the railroads, bridges, and other means of communication may be considered military objectives, it is obvious that any city population is chiefly civilian, including numbers of women who are not munition workers, not to speak of invalids, old people, children and babies. It also includes neutrals. Accordingly the proposal to bomb cities from the air opens a new phase of a question which is as old as man, *i. e.*, how far it is useful, desirable or necessary to inflict the cruelties of war upon civilians, especially the completely nonmilitary categories of civilians, and most of all upon neutrals? Certainly their immunity can never be complete, but throughout most of recorded history civilized peoples have tried to extend it as far as they could without prejudicing the chances of victory.

In general, our ancestors realized that any cruel or destructive act which did not directly promote victory was not only a crime but a blunder; if one intended to conquer a given territory, then it was clearly desirable to preserve the wealth of that territory; if on the other no annexation was proposed, it was still desirable to destroy life and property as little as possible so that one's temporary enemy might become a valuable commercial customer after the peace. The same sensible consideration of a future peace further discouraged all unnecessary cruelty, because such cruelty arouses hatreds long and difficult to heal. As to retaliation, our ancestors were usually wise enough to avoid carrying it far, because their reason told them that two can play at that game. With combatants of fairly equal strength, retaliations and barbarities pretty much canceled out. Accordingly, to indulge in them merely increased the evils of war without approaching war's rational goal of a victory calculated to bring a better peace. Not only eighteenth-century statesmen and jurists like Vattel but also hard-headed soldiers like Vauban were unanimous on the point. Our ancestors also saw that retaliation has no logical halting place; if both sides try to outdo each other in spreading terror by savage actions, they can end only in totally exterminating the conquered.

If airmen are to bomb cities indiscriminately, there is no reason to complain of submarine commanders for sinking merchantmen without warning; nor would there be reason to blame men in surface ships who might treat merchantmen as harshly, or might bombard any undefended fishing village. If mere terror be the object, armies could easily outdo air forces by massacring every man, woman and child whenever they occupied hostile territory. There is also the neutral to be considered. His sympathies are always important and often decisive. If Germany had not invaded Belgium in 1914 she might not have had England against her; in 1917, without her unrestricted submarine warfare, she would not have had the United States for her enemy. In either case she would have won the war. In her case frightfulness proved a disastrous boomerang. To succeed at all, it must achieve an immediate decision before it brings in the neutral world against its perpetrator. The old-fashioned military honor which despises needless cruelty is not only a virtue; it is often a solid practical advantage as well.

Measuring Cannon Pressures

Present Methods and the Possibility of New Developments

By Henry N. Marsh *

SINCE modern artillery is designed for maximum possible performance with definite limits as to weight to obtain greatest possible mobility, it is not customary to allow a very high factor of safety against bursting pressures. In fact we doubt whether any modern artillery is designed with a factor of safety as large as 2 with repect to specification maximum chamber pressures. With this situation it becomes vitally important to have some methods of determining the maximum chamber pressures developed in a cannon. While the methods now in common use may not actually record the true level of pressure, they should be consistent and reproducible.

Several methods may be used to determine the pressures developed by the propellent charge in cannon. These methods will be listed and briefly described below after which an effort will be made to evaluate them and offer some suggestions for improvements.

The methods which have been or are being used for this purpose are: (1) Rodman crusher gage; (2) Present standard copper crusher gage; (3) Optical spring gage—Petavel; (4) Thring pressure recorder; (5) Kirner lens gage; (6) Piezo-electric gage; (7) Small arms radial gage applied to cannon, and (8) The dynamic method.

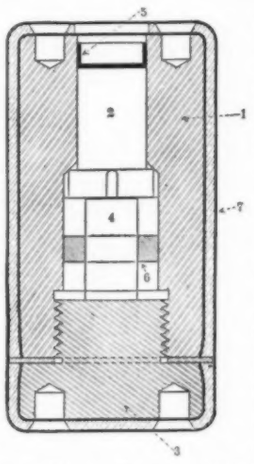


FIG. 1. LOOSE CRUSHER GAGE

Methods (1), (2) and (8) are the only ones of the list above which may be used in any weapon without alteration of the weapon, which makes it useless for further field use. Methods (3), (4) and (5) are used generally for investigation of the performance of a powder in closed bombs and offer almost insurmountable difficulties in their application to a recoiling gun barrel.

To clarify further discussion, let us now consider briefly the details of these various methods of determining pressure:

One of the first successful efforts to determine with some degree of accuracy the maximum pressure developed in a cannon, was made by Rodman about 1857. He used a gage not materially different in principle from the present crusher gage (*sic*) except that he used a knife edge on the end of the piston and determined the level of pressure by measurement of the depth that the knife was driven into a block of copper. His classic experiments, coupled with the better knowledge of the pressures obtained in cannon, led to improved performance of the weapons and also aroused an active interest in the measurement of pressures which led to our present copper crusher gages.

These gages (Fig. 1) consist of a steel housing *1*, in which is closely fitted a piston *2*, which applies the pressure developed in the gun on a cylinder of accurately dimensioned copper rod *4*, which is in turn supported by the anvil which is a part of the closing cap, *3*. For accurate results it is necessary that there be no gas leakage either past the piston or through the thread of the closing cap. This is accomplished by the use of a gas check *5*, over the head of the piston and by the use of a flexible copper gasket between the housing and the closing cap. The outside surface is covered with a copper covering *7*, to avoid damage to the bore of the gun during firing.

The measurement of pressure is accomplished as follows: The various parts of the gage are disassembled and examined carefully to determine whether they are in good condition. The piston after oiling is inserted in the piston hole. Next a copper crusher cylinder is carefully checked for length and is passed through a rubber washer *6*, of such dimensions that it will serve to center the cylinder on the piston in the housing. This is inserted in the housing, a copper gasket is put on the closing cap and with proper wrenches the closing cap is tightened. A lubricated gas check is placed in the piston hole. The gage is then inserted between the breech face and the powder charge, in the larger guns, or in the bottom of the cartridge case under the powder in fixed ammunition. On the larger seacoast guns it is screwed into the breech block with the piston end toward the muzzle. The round is then fired. The gage is recovered and opened, and the remaining length of the copper determined. This length is then compared with a tarage table and the corresponding pressure read. The tarage table is constructed from data obtained by compressing identical coppers of the same anneal under known loads and measuring the decrease in length.

The Petavel gage has little application to cannon pressures but has been extensively used in investigations of the performance of powder when fired in closed chambers. A piston hole of known diameter is bored through the wall of the chamber and a piston fitted. The rounded head of the piston presses against the center of a very stiff short bar spring suitably supported near the ends. One end of the spring has been polished to a mirror finish or a small mirror is mounted on it. The flexure of the spring is recorded photographically by a revolving-drum camera through a suitable system of light and lenses by means of light reflected from the end of the spring.

The Thring pressure recorder was designed for use on small arms by Mr. G. P. Thring of Cambridge, England, and has been used to some extent in the Research Department at Woolwich Arsenal, England. It is described in the British "Textbook of Small Arms", 1929.

THE Kirner lens gage contemplates the determination of pressures by photographic recording of the spreading of Newton rings. It makes use of glass lenses of sufficient strength to withstand chamber pressures and develops the record by causing the lens exposed to chamber pressure to bear upon a second lens rigidly supported. Its principal advantage is that inertia effect is negligible although it is complicated in use.

* Hercules Powder Company, Wilmington, Del. Major, Ordnance Reserve, U. S. Army.

The piezo-electric method offers many advantages over the methods previously outlined and is now in use for research work though not adaptable to routine testing. This will be discussed later. This instrument (Fig. 2) gives an accurate, continuous record of the time-pressure curve in the gun. It is based on the behavior of certain types of crystals which, when compressed on their main axis, develop an e.m.f. which is directly proportional to the pressure applied. For ordnance use and other high-pressure work, it is customary to use quartz crystals. It is necessary to select the crystals, since not all forms show this behavior, and then cut from them, discs with their plane faces perpendicular to the electric axis which may be determined by experiment. The flat surfaces of the discs must be in true parallel otherwise the calibration of the gage is not constant and there is considerable danger of breakage.

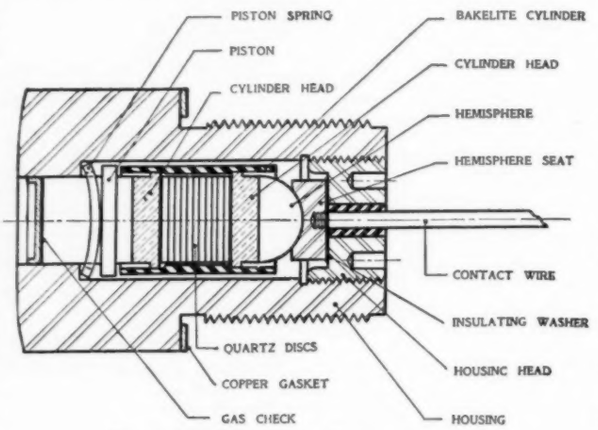


Fig. 2. Piezo-electric Pressure Gage

The discs are faced with positive and negative sides touching and separated by thin metal plates. The positive plates are connected to one terminal of the gage and the negative plates are grounded to the body of the gage. The e.m.f. developed by the discs is recorded through connection to an oscillograph and drum camera.

The calibration of the gage is accomplished by application of known pressures by a hydraulic testing machine equipped with a quick-release mechanism. The sudden release of pressure on the quartz produces an effect on the same order of magnitude as the sudden application of pressure and thus it is possible to construct an accurate calibration curve.

The small-arms radial gage, which is in principle the same as the copper crusher gage, has in a few cases been applied to cannon pressure measurement. On this system a piston passes through the gun barrel into the chamber and exerts the force from the burning of the powder on a copper crusher cylinder supported by an anvil rigidly attached to the barrel. The principal faults of such a gage in comparison with standard copper crusher gage lies in the materially increased weight of the piston which increases the inertia effect; in the much higher cost of repair or replacement, after wear has ended the accuracy life; and in its lack of applicability to large guns. Such gages have been used experimentally in the 37-mm. gun, mod. 1916, and in some of the trench mortars.

THE dynamic method of pressure measurement is based on determination of the velocity of the projectile while it is in the bore, or by measurement of the velocity of the recoiling gun at different points during recoil. From these data it is possible to calculate acceleration and thus determine the pressures necessary to produce the effect. This method takes no notice of that part of the pressure which overcomes the friction of the projectile in the barrel or the part which causes rotation. In spite of this, pressures so determined are generally higher than those shown by copper crusher gages, though not so high as is shown by the piezo-electric gage.

As pointed out in the beginning of this paper, most of the methods we have discussed require such modification of a gun as would render it unfit for field service. In addition methods (3), (4) and (5) require the use of additional photographic equipment in such manner as would probably prevent their use on cannon recoiling in normal manner. For these reasons, our further discussion will be confined to method (2), the copper crusher gage; (6), the piezo-electric gage; and (8), the dynamic method. It would be impossible for the writer to sum up the merits and comparative accuracy of these three methods more clearly and concisely than is done in "Ordnance and Gunnery" by Col. Earl McFarland (1929) from which we quote briefly. On page 103, Colonel McFarland states:

"(a) The piezo-electric gage gives numerical values very close to true pressures; (b) The maximum pressures obtained with the piezo-electric gage are from 15 to 20 per cent higher than those determined by the crusher gage; (c) The quicker the powder, the lower the pressures indicated by the crusher gages and the greater the difference in the results obtained by the two methods; (d) Pressures determined by the dynamic method from the velocity of recoil are consistently higher than those determined from the velocity of the projectile; (e) Pressures obtained by the piezo-electric gage are higher than those calculated by the dynamic method, using either the velocity of recoil or the velocity of the projectile."

THE piezo-electric gage, with the improvements in technique that have resulted from its use, is now believed to record pressures close to the true level and is readily adapted to research work. It is not, however, adapted to routine work for several reasons. First, because it is necessary to provide for mounting the gage in the chamber of the gun and leads from the gage through the chamber walls or through the breech block to the recording equipment; secondly, its use requires elaborate accessory equipment, consisting of oscillograph, revolving-drum camera, recording tuning fork for time record, a dark room—all of this sufficiently remote from the gun so that the shock of discharge of the gun does not disturb the record; and thirdly, the time delay after firing before it is possible that the result may be known, due to development, drying and measurement of the record on the film.

The copper crusher gage as used now, no doubt records pressures considerably below true level but it generally gives comparable results and may be used without damage to or alteration of the service piece. The results are quickly obtained without elaborate equipment and serve adequately for the proofing of guns, powder and ammunition lots. A change in the instructions now given in the Proof Officer's Manual (1929) with regard to the use of precompressed coppers was recommended to the Chief Proof Officer, Aberdeen Proving Ground, in a letter addressed to him by the writer dated September 29, 1933. This was based on a rather limited statistical study of firing records. The recommendations were:

"1. That precompressed coppers be used for all cases where expected pressure is in excess of 30,000 lbs. The precompression used should be from 10,000 to 15,000 lbs. less than the expected pressure, and after precompression all coppers should be discarded which fail to show expected set within a tolerance of ± .0015 inch. 2. That exact initial lengths (of coppers) be used, or at most, a tolerance from length of not more than ± .0005 inch. 3. A system be installed which will point out the gages which are frequently in serious disagreement."

A logical corollary of the third recommendation is of course, the rejection of and removal from use of all gages which are in serious disagreement particularly when those gages are low.

The use of interior copper crusher gages in the chamber of the gun reduces the chamber capacity by their volume and results in higher pressures and velocities than when the same powder charge is fired under service conditions in a normal gun. Such increases do not occur when using methods (4), (7) and (8) and to a much lesser degree with method (6). It is, of course, possible to apply corrections for the presence of the gage in the chamber to both the pressure and velocity and these corrections should be applied to all records taken with interior pressure gages. One other source of error with copper crusher gages may be due to careless or improper methods of inserting and seating the gas check in the mouth of the piston hole as the final operation of the assembly. It is difficult to seat the gas check without canting unless a properly shaped tool is used which fits the gas check exactly, but does not press against the bottom of the check. Frequently the gas checks are scored in inserting and this nearly always results in false records due to leakage. This source of trouble is more prevalent with the gages which are incased in copper for protection of rifling and it is desirable that the copper casing be reamed well away from the mouth of the piston hole in the body of the gage. We believe that this type of trouble from the use of gas checks is more prevalent than usually realized and might be entirely eliminated in the manner discussed immediately below.

If the fitting of the piston to the piston hole were more accurately done and the precision of manufacture held to closer tolerances throughout the gage, it would be possible to dispense with the gas checks entirely. We recently examined a set of Krupp cannon gages that had been extensively used. They were of such precise manufacture that even now when assembled without copper gaskets on the closing head (as is proper practice with their design) they were gas-tight, and if the piston were pressed down and held for as much as five minutes it would return immediately to the top position from air compression. These gages were used without copper gas checks, only a small amount of Russian wax being used on the open end of the piston. We make this suggestion because we believe there is a possibility of low results being due in part to the adhesion of the gas check to the sides of the piston hole so that a part of the pressure applied is expended in the elongation of the gas check and not on the compression of the copper crusher cylinder.

This matter of adhesion is also evidenced at times, particularly on high pressures, when the copper crusher cylinder shows a distinct tendency to assume a barrel shape; that is, larger in diameter at the center point than at the ends. This must be due to the cohesion of the copper to the piston head and anvil thus resisting the flow of the copper across the piston anvil and absorbing energy which should be expended in reducing the length. This difficulty may be overcome by oiling the faces of the piston and anvil, but only serves to illustrate the possibility that adhesion may take place by the gas check in the piston hole.

We would further recommend that tests be made to determine the feasibility of the following suggestions which have resulted from discussion of this problem.

ONE of the principal difficulties with copper crushers is the lack of uniformity of anneal from lot to lot and between coppers in the same lot. Another difficulty is the relatively large deformation for high pressures which must be accomplished in a very short time. We suggest that the copper crusher be replaced with a disc of mild steel and that the head of the piston be modified to be equivalent to the indenting point of a Brinnell hardness testing machine. If such a device were used, the travel of the piston under high pressure would not be more than a small fraction of the amount with a copper crusher cylinder and one would have the further advantage of being able to calibrate and check any doubtful result by the use of a Brinnell hardness tester on other areas of the same disc of metal used in the test. To insure a short travel of the piston, it may be necessary to substitute harder steels of higher carbon content for the mild steel disc recommended, and it is appreciated that calibration indenting might have to be done with a falling weight or some other sudden application of force to eliminate the influence of elasticity of the steel.

A method of measuring pressures which has not been applied to ordnance use to the best of our knowledge is based on the change in electrical resistance of a conductor due to pressure. According to Glazebrook, the formula for platinum wire is:

$$\frac{r - r_0}{r_0} = - 1.86 \times 10^{-6} p$$

where p is expressed in atmospheres and r equals resistance at atmospheric pressure, and r_0 resistance at any other pressure. It should be possible to mount a length of platinum wire in the chamber of a gun so connected to an indicating ohmmeter that a recording of the resistance variation could be made photographically on a revolving-drum camera.

After considering the various methods of measuring pressures in cannon, we conclude first, that the piezo-electric gage gives most accurate results and is suitable for research work but not for routine testing; and secondly, that the standard copper crusher gage as now used may be improved in its performance to give results nearer to true pressure level.

Fixed-Barrel Automatic Firearms

Their Greatest Development Came Before the Turn of the Century

By Heinrich Wimmersperg *

IT is the intention of this article in discussing automatic, fixed-barrel firearms, to present several little-known systems which are of interest both technically and historically, rather than to cover the field completely. Test arms and those already in use in large armies are described often enough in the literature; we shall therefore consider them as known and exclude them from our discussion.† For the constructor, it is important to trace the line of development and to become acquainted with those weapons also which were not a commercial success. Their failure in this respect was not in every case due to technical imperfection. Also from the standpoint of historical justice, the constructions which form the foundation of our present automatic-firearm development should not be ignored. It is our intention to stimulate interest in this direction.

The problem of constructing a self-loading rifle using the ordinary infantry cartridge has always been one of the most difficult problems of weapon technique, and it still remains so. A movable barrel reduces accuracy of fire and makes a heavy barrel casing necessary. Moreover, most of these systems require long breech bodies. If the barrel is fixed, then the problem to be solved is: how can a premature opening of the breech bolt be avoided during the period of high gas pressure?

The blow-back type cannot be used for self-loading rifles on account of the weight limitation. The retarded blow-back breech-closure principle, as used by Pedersen, for example, shows the possibility of retarding the opening of the breech bolt sufficiently, with a light-weight breech system. This system is well known. It is less well known, however, that A. W. Schwarzlose laid down the fundamental principle of keeping the eccentricity of the toggle link small at the beginning and thus retarding the breaking of the elbow joint (Fig. 1). In his English patent No. 2464, dated January 30, 1913, we find:

"The rear link has two axes of rotation which successively

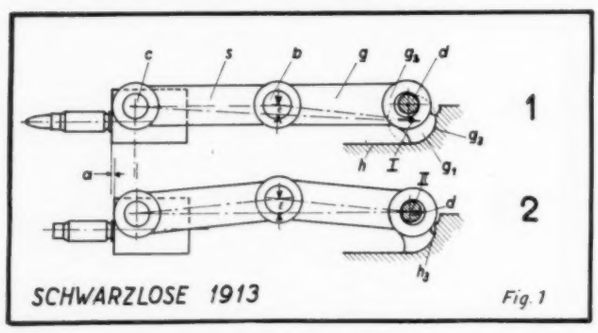


Fig. 1

come into operation, thus delaying the opening of the breech. The breech casing *h* is rigidly secured by means of screw threads to the barrel; the branches *s* and *g* of the knuckle are connected at the bending point by means of the bolt *b* and with the breech casing by means of the wing shaft *d*. In this instance, the branch *g* is provided however at its rear end with an additional pivot g_1. The rear part of the latter forms a cylindrical surface g_3, the axis of which is I. When the breech mechanism is closed, this surface bears securely against the milled-out portion h_3 having the same radius of curvature of the breech casing *h*, whilst the two

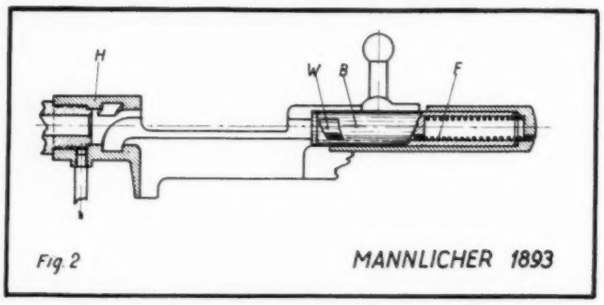


Fig. 2

lateral trunnions g_2 of the branch, the axis of which trunnions is at II, are at the same moment at a distance of about 0.3 mm. from their rear bearing surfaces in the breech casing.

"Now, when at the moment of firing, the branch *s* of the joint, the front axis of rotation of which is at *c*, is thrown upwards by the back pressure of the cartridge head, the rear branch *g* first rotates round the axis I until the bending axis of the knuckle joint has been swung into the position 2. During this movement, the two fulcrums g_2 of the rear branch have moved backwards to such an extent that their rear bearing surfaces are in close contact with the corresponding surfaces of the breech casing. During the continuation of the movement of the bending point, the knuckle opens, the rear branch therefore rotates round the axis II, its pivot or fulcrum g_1 swinging then forwards out of its bearing h_3."

The fundamental principle of the Pedersen self-loading rifle is here clearly stated. The constructive application is somewhat different, possibly simpler.

The method laid down by J. Blish in his English patent No. 14,368 of June 30, 1913, was also tried out in practice many years earlier. Thus, in 1893, the prominent Austrian inventor Ferdinand von Mannlicher constructed two semi-automatic rifles with rotary bolts and steeply inclined locking lugs. In his English patent No. 16,548 (1893) we find:

"A longitudinal section of the gun (Fig. 2) is shown with the breech open. The breech bolt *B* recoils against the action of the spring *F*, which returns it to its former position. The spring is arranged to impart a twisting motion to the breech bolt, so as to turn it for locking. Wings *W* are provided on each side of the breech bolt which run in longitudinal guides and then turn into recesses for locking the breech bolt. The wings and locking grooves resist the opening of the breech at the moment of discharge, while allowing the pressure of the powder gas to turn the breech bolt and then to retract it."

A further development of the same type is described in

* Mechanical Engineer, Vienna, Austria.

† Refer to the article by J. S. Hatcher, "Automatic Firearms," ARMY ORDNANCE, March-April and May-June, 1933, (Vol. XIII, Nos. 77 and 78).

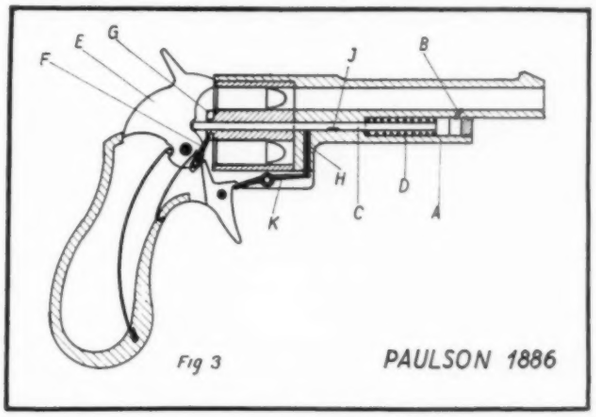
English patent No. 2687 (1894). The breech bolt is of the straight-pull class. It is prevented from rotating by ribs which move in guides in the breech casing. When the rotary bolt is driven back by the force of the explosion, it rotates and unlocks itself while at the same time it unscrews the breech bolt. The essential fact is that the resistance shoulders on the body into which the locking lugs grip are not perpendicular to the axis of the barrel, but are so much inclined that the friction does not prevent the unlocking of the bolt.

Blish did indeed attempt a new explanation of his principle but his construction in effect was identical with the gun invented twenty years earlier. If Blish's theories had been correct, his gun would have functioned without lubrication of the cartridge, which was not the case. When ordinary infantry cartridges are used, all systems in which the breech bolt opens while the gas pressure is still high must provide for lubrication of the cartridge case. All lubricants smoke at high temperatures. This is the great disadvantage of this breech-closure principle. The ordinary gas-operated type is much superior in this respect. The breech bolt does not open until the gas has escaped. Lubrication of the cartridge case is unnecessary. John M. Browning is usually considered the inventor of the principle of conducting the gases to a piston which activates the breech bolt. But in 1863, we find that Orbea invented a revolver, now in the Museo de Armeria at Eibar, which ejected the empty case of the previous shot from the chamber by means of a piston actuated by the powder gases. A revolver which is cocked by a piston driven by powder gases which also turn the cylinder is described in Richard Paulson's English patent No. 14,130 (1886): "The barrel itself may be secured in its place as heretofore, in which case I may utilize the force of the exploding gases, so that they may cause the breech mechanism to be operated. To accomplish this, I prefer to make a small inclined perforation into the barrel, lining the same with any suitable noncorrosive metal to prevent it being injuriously affected by the explosive gases. This perforation is made to communicate with a small cylinder, placed under or at the side of the barrel; inside the cylinder I place a small piston, which is held in its place by a small coiled or other spring. At the instant of discharge, the pressure of gases in the barrel being driven through the aforesaid small opening into the cylinder, forces back the piston and spring or springs.

"The piston *A* (Fig. 3), placed under the barrel, is operated by the gases generated by the explosion passing through the small perforation *B* in the barrel, and forces the sliding rod *C* against the resistance of the spring *D*, and presses back the hammer *E* thereby cocking it and turning the chamber by means of the pin *F* engaging in the teeth *G* in the ordinary way. The small lever is controllable by the trigger and the spring, thus the pin *H* may be made to enter the catch *J* which retains the sliding rod *C* back against the pressure of the spring *D* until the trigger is released from the pressure of the finger as the weapon is fired. When thus liberated, the sliding rod *C* is forced back into its original position by the spring *D*, and the weapon is thus again ready for firing, while without the aid of the said lever *K* and locking pin *H* to retain the rod *C* at each discharge as aforesaid, one pull or pressure on the trigger would cause the whole of the chambers to be discharged in rapid succession."

Here we find all the fundamental principles of the gas-operated gun. It is of no importance basically what feeding and breech-closure systems are employed. With gas-operated systems, the gas pistons must have a certain amount of weight in order to assure good function. The gas cylinder also must be rather long on account of the long way traversed by the piston. Both these requirements are unwelcome with self-loading rifles. Systems were therefore sought where the piston could be made lighter or avoided entirely, without needing to use a movable barrel or to open the breech bolt prematurely.

OF late years, the Scotti self-loading rifle has been mentioned frequently. The Scotti action may be described as follows:



The barrel is screwed into the body *H* (Fig. 4). The breech bolt *B* is driven forward by the spring *F* and bears the bolt head *C* with the locking lugs *W*. The two are so connected that the breech bolt turns the bolt head to the right at the end of its preliminary movement, as we see, for example, in the Austrian straight-pull Mannlicher rifle model 95. The gas piston traverses only a short path *a;* it is driven forward by the spring *K*. The locking lugs *W* are inclined at an angle of 60°. They are prevented from being screwed out when the rifle is discharged by a claw *N* on the breech bolt.

When the gases throw back the piston, it drives back the breech bolt *B* and this in turn frees the locking lugs *W* and turns the head *C*. This turn requires little energy, as the remaining gases have a tendency to press the head backward, and to screw it out. The breech bolt runs back and compresses the spring *F*. The trigger always catches the breech bolt in its rear position. The gas piston returns immediately to its original position. When the trigger releases the breech bolt, this inserts a new cartridge, turns the head *C*, and locks it with the claw *M*. Then it primes the cartridge with the firing pin *G* which is fixed in the breech bolt.

The Brevetti-Scotti Co. in Oerlikon, puts out a 7.9-mm. rifle of this system. Various test arms—for example machine guns up to caliber .20, and a machine cannon of caliber .37, were built earlier according to this system—and even a small automatic pistol. It is hard to understand what the reason for constructing the last-mentioned weapon could have been. The machine guns require a separate oiler for the breech bolt.

This system, too, is over thirty years old. The Mannlicher self-loading rifle model 1900 was identical with the Scotti action. We read in the English patent No. 16,735 (1899): "The breech bolt *B* (Fig. 4) is provided with a recess to receive the projection *M* of the gas piston *P*. When the gun is discharged, the piston *P* receives a rearward impulse from

the powder gases and its projection *M* acts on the side of the recess, and first rotates and unlocks the breech bolt and then throws it backward while the piston is returned by a spring. The breech bolt *B* in its rearward opening movement compresses the spring *F*. This spring *F* is attached to the breech bolt and also to the breech casing, so as to act torsionally as well as longitudinally. It therefore not only returns the breech bolt to its forward position but also rotates and locks it with the locking part *W*. In a modification of the breech action, the breech bolt is of the straight-pull type and is locked by a jointed piece under the action of a spring. When the gun is discharged, the gas piston will be driven rearward and unlock the breech bolt."

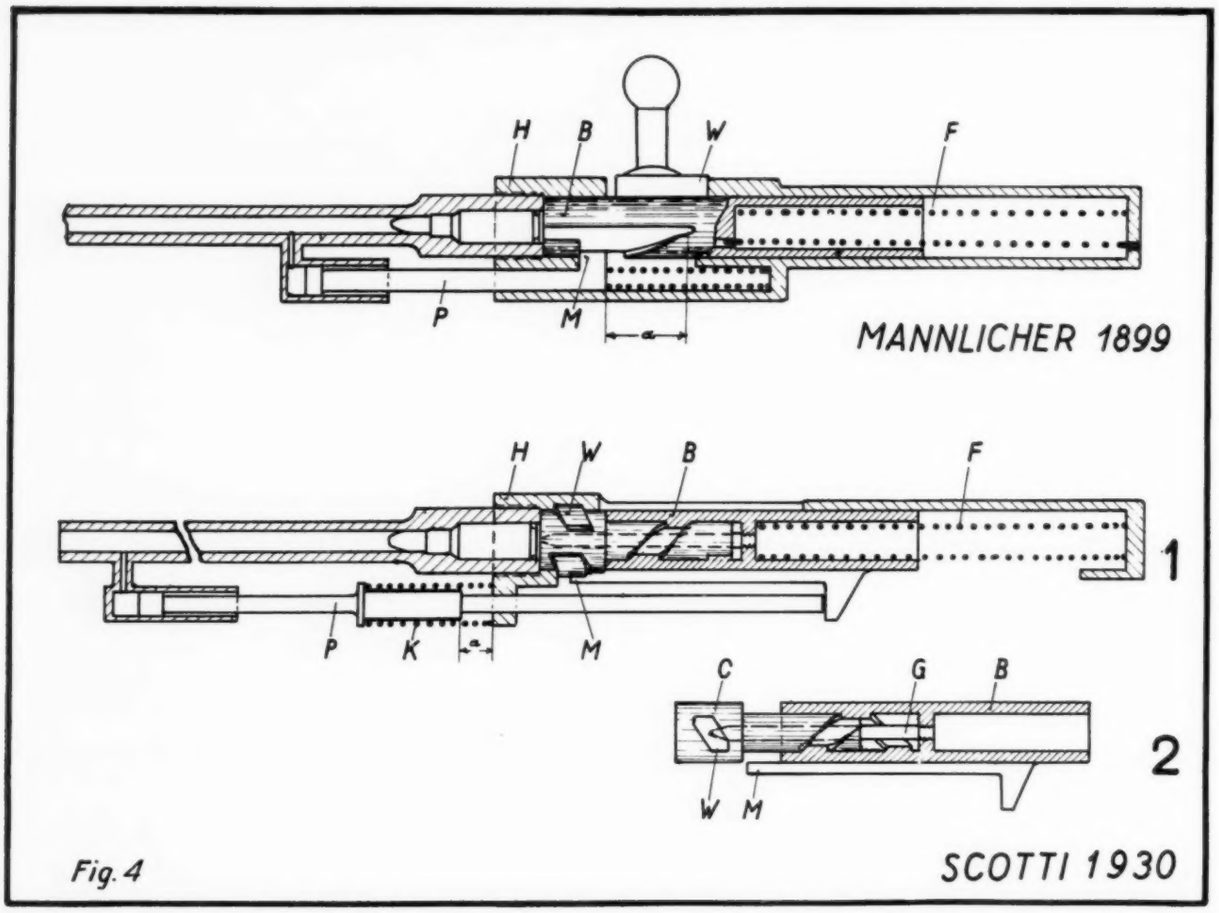


Fig. 4

The modification mentioned is so similar to the Scotti system that it is unnecessary to present a special diagram of it. The only difference between the two systems is that Scotti employs more steeply inclined locking lugs, and that the vent in the barrel is nearer the muzzle.

The same fundamental principle, that of locking the breech bolt until the projectile has reached a certain point and then unlocking the breech bolt by means of a gas-actuated piston, is also employed by Karl Heinemann, whose self-loading rifle was constructed and patented in 1927 by the Rheinische Metallwaren und Maschinenfabrik in Düsseldorf (German patent No. 494,389).

The toggle joint *S* and *G* (Fig. 5) locks the breech bolt in the normal position, and is held in this straight position by a spring and also by a catch not shown in the drawing. The pin *D* is fixed in the body *H*. On the muzzle, there is a movable cap *M* which is attached to the connecting rod *C*, pressed backward by the spring *J*. When the gun is discharged, the toggle joint remains locked until the projectile has left the barrel and the gases propel the cap *M*. This causes the inclined part C_1 of the connecting rod *C* to move toward the pin *E* of the toggle joint and to break the latter. It releases the catch not shown in the drawing somewhat earlier. The rest of the powder gases press on the cartridge case, which drives the breech bolt backward; this breaks the toggle joint completely. The muzzle cap *M* is moved backward at once by the connecting rod *C*.

The spring *F* stretches the joint again and brings the breech bolt into the forward position. There is a separate part provided (not shown in the drawing) which strikes a second time on the joint after the latter is straight in order to reduce the vibrations, so that the catch may lock the joint. It is clear that the weapon is not particularly simple. This course of development is often repeated in all technical fields; in the effort to simplify, so many auxiliary attachments must be added that the final product is much more complicated than the original article. The toggle joint is a less convenient construction than the simple rotary bolt as used by Mannlicher, Scotti, and others for this type.

THE problem of locking the rotary bolt with steeply inclined locking lugs during the period of high gas pressure was solved in 1914 by Mauser in another way. The construction is described in English patent No. 3198 (1914).

"The breech consists of the longitudinally displaceable

breech bolt *K* (Fig. 6) and the bolt head *V* located rotably in the said breech bolt, and carrying the locking lugs *W*. The sleeve *H* of the breech casing, receiving the barrel, is provided with notches or recesses in the usual manner, behind shoulders of which the lugs *W* pass when in the locking position and thus close the breech.

"The lugs *W* and the corresponding shoulders are relatively beveled in such a manner that the said lugs can be withdrawn from the recesses formed in the sleeve, partly owing to the recoil action and partly owing to the remaining gas pressure. The locking member is a slide *S*, displaceable in the direction of the movement of the breech bolt, and guided within the wall of the breech casing, so that as soon as the locking lugs have attained the closed position, it also reaches the closed position under the action of a spring. The locking takes place by the direct coöperating of the locking slides with the locking lugs. When the shot is fired, the slide by its inertia moves forward relative to the breech bolt, so that the previously retained locking lugs can effect their releasing rotation past the shoulder *T*. When closing, the converse operation takes place."

Simson and Company, arms manufacturers in Suhl, Germany, attempted to solve the problem of unlocking the breech bolt in the following manner (German patent No. 554,834, 1930): The breech bolt *B* is locked by a rotary catch *W* activated by a spring (Fig. 7). Under the rotary catch, there is a second hammer *K* on the axis of the hammer *H*. Both hammers are actuated by springs. The hammer *H* is prevented from turning by the sear *T;* the hammer *K*, by the catch *C* (position 1). When the trigger is pulled, the hammer *H* is released; it runs upward and primes the cartridge and at the same time turns the lever *L* which presses back the catch *C* (position 2). The hammer *K* is thereby released and strikes against the arm of the locking catch *W* and turns it (position 3). The breech bolt is unlocked and the rest of the propelling gases drives it back. The breech bolt remains closed during the period of high gas pressure. The period between discharging and unlocking the gun can be regulated.

This solution is interesting and appears simple, but the function depends on exact tension of the spring and on friction. Aside from this, accidents are possible with hang fires, as unlocking the breech bolt is independent of the timing of the gas pressure.

The idea of having a heavy part not participate in the recoil in a shoulder weapon, and of using its relative movement to actuate the loading mechanism, was presented for the first time by the Swedish engineer Carl Axel Sjögren, who built several rifles according to this system from 1900 on. A hunting rifle of his was in wide use until it was replaced by the Browning self-loading rifle. In the English patent No. 14,661 (1901), the Sjögren gun is described as follows:

"The weight (1) is movable on the breech block (2). In a boring in the said weight is provided the spring (4) which is adapted to throw the weight backward after the recoil has ceased. The weight (1) engages by means of a pin (10) with two horizontally turnable angle levers (11), which are mounted on the breech block (2), and the fore ends of which are formed as hooks (12), adapted to engage corresponding hooks (13), rigidly connected to the barrel, when

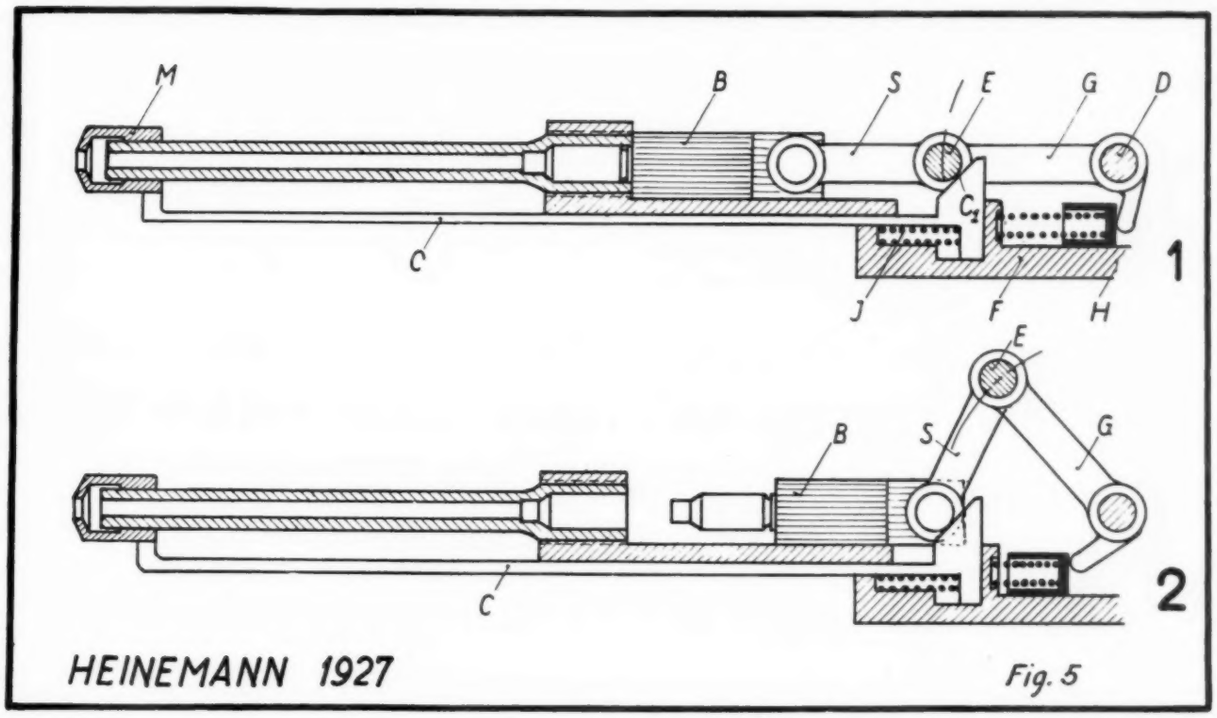


Fig. 5

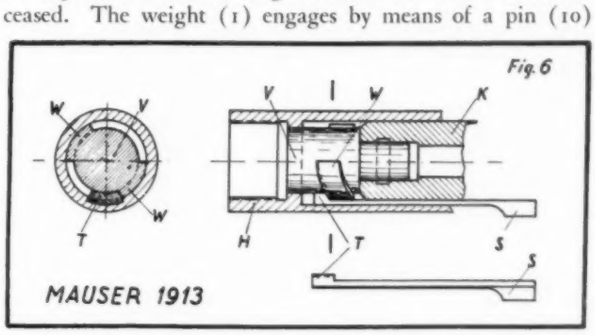


Fig. 6

the breech block is in its closed position, as shown in Fig. 8, position 1. The rear end of the said angle levers are close to each other in the said position of the breech block and can never be turned so far from each other as to let through the said pin (10) inasmuch as the same, when they are turned by the pin in the backward movement of the weight, will strike inclined surfaces (16) of the breech block, limiting the movement of the said angle levers. The weight (1) will thus in its backward movement first disengage the angle levers from the hook (13) and thereupon, by means of the said angle levers, throw the breech block backward. The spring (22) is adapted to bring the breech block back into closed position.

"When the different parts are in position 1, in which the gun is ready for firing, and the trigger is operated in the usual manner, the firing pin causes firing in the usual manner. The gun now recoils and the weight (1) moves forward, whereby the spring (4) will be compressed (position 2). When the recoil has ceased, the spring (4) will throw the weight backward, whereby the pin (10) will first disengage the angle levers (11) from the hooks (13) and thereupon bring the breech block (2) backward (position 3) until the weight strikes the block (24). As soon as the weight (1) has struck the block (24), it will be brought back into position 1 by means of the spring (22), whereby also the breech block (2) will be returned to its initial closed position, and the angle levers (12) will again be thrown into engagement with the hooks (13) by means of the spring (4), the fore end of which for this purpose bears against the rear ends of the said angle levers (12). The gun is thereupon ready for new firing."

Sjögren also constructed several modifications of his system with rotary bolts. A disadvantage of all systems which employ the relative movement of a heavy part during the recoil, is that they are in large measure dependent on the firing position of the marksman.

A SOLUTION sometimes used for pistols and submachine guns is that of allowing the whole cartridge case to recoil a few millimeters in order to accelerate the breech bolt which then unlocks and withdraws the proper bolt head after the projectile has left the muzzle; *e. g.*, Remington pistol model 51; submachine gun Schweitzerische Industrie — Gesellschaft, Neuhausen. This solution is only possible for a cylindrical cartridge case but not for the relatively thin-walled bottle-shaped rifle cartridge which would be ruptured under the high pressure.

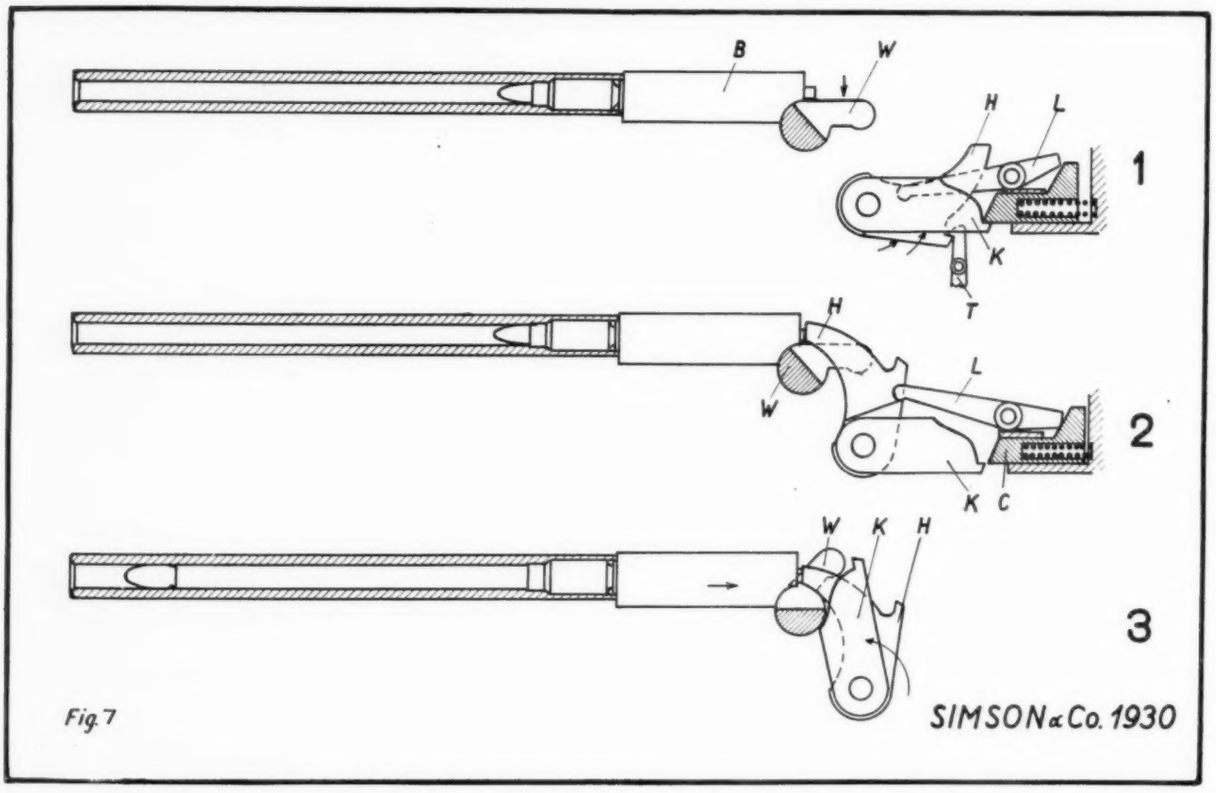
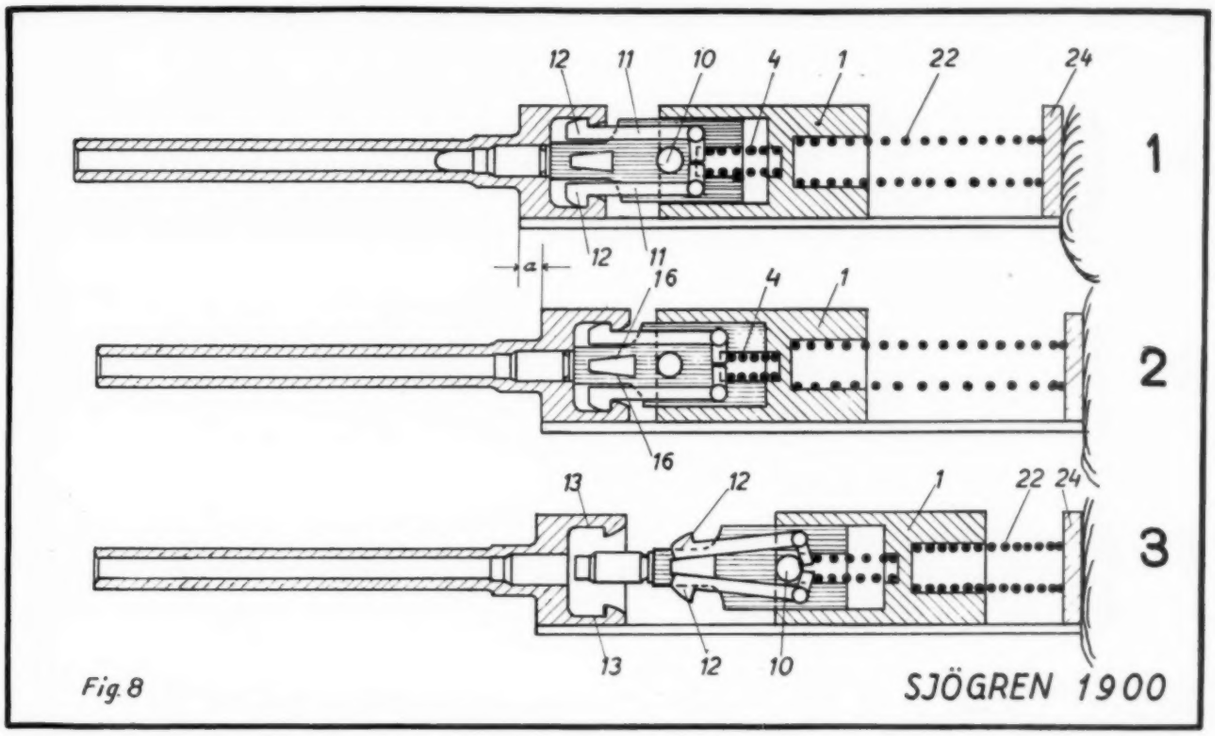


Fig. 7

The system of primer-actuated self-loading rifles appeared to be very promising for some time. It is described in Army Ordnance in an article by J. S. Hatcher in the May-June, 1933 issue (Vol. XIII, No. 78), and by H. Wimmersperg in the March-April, 1936 issue (Vol. XVI, No. 95). It is one of the oldest and one of the most ingenious solutions.

We see in these few examples that the most original ideas occurred and were realized before the turn of the century. We find almost no new ideas later. We have entered a period of sterility in gun construction. Even the great success that the German engineer Gerlich enjoyed around the year 1930 with the increase of the muzzle velocity from 875 meters per second to about 1800 meters per second—which was certainly the greatest stride in the development of firearms—was based on ideas patented twenty-five years before by Carl Puff. Puff writes in his English patent No. 16,607 (1907) as of the year 1906:

"This invention relates to the inner arrangement of firearm barrels, which are intended to fire projectiles which, besides

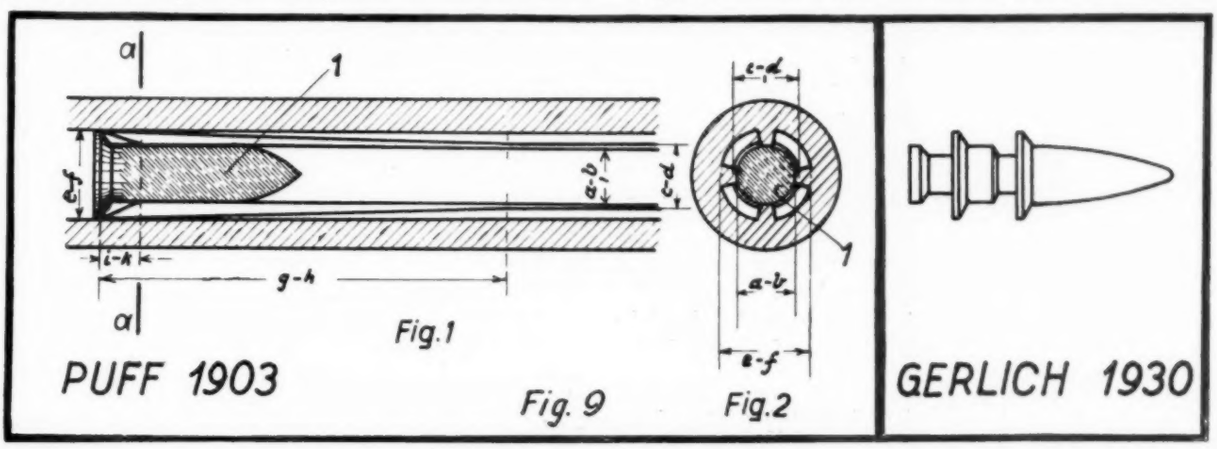


the usual guiding and tightening projections, are also provided with special, separable driving plates, or discs or compressible reinforcements or collars acting as driving plates, these driving plates or equivalents offering a larger pressure area and providing a smaller section charge of the projectile especially at the beginninng of the development of the gases.

"Such projectiles have been fired until now by means of strongly conical barrels, or barrels the bore of which has been enlarged in a manner corresponding to the diameter of the driving disc. It follows that the collars or driving discs of the projectile which have a considerably increased diameter, must be very long in the well-known arms of the kind described if the projectile has to be guided in a sufficient manner and if the effectiveness of the arm is to be satisfactory, or besides the collars or driving discs, centering collars must also be arranged more in front of the projectile whereby the manufacture of the projectiles becomes more complicated. According to the present invention, the barrel is essentially cylindrically bored according to the caliber proper of the projectile, whilst the grooves are deepened more than usual and necessary for the guidance of the projectile so that they are fitted only by the larger collar arranged on the projectile or by the driving discs, but not by the body of the projectile."

"In Fig. 1 of the drawing (Fig. 9) *a-b* is the bore proper of the barrel; *c-d*, the normal depth of the grooves; *e-f*, the deepened part of the grooves on the length *g-h*; *i-k* is the transition cone formed by beveling the rear ends of the lands; (1) the body of the projectile. The collar or driving disc (2) is driven forward together with the projectile (1) by the gases evolved, whereby the projecting surfaces or lands left between the deepened grooves are pressed into the collar or into the driving disc and the latter are, during the further advancing motion of the projectile in the barrel, compressed down to the bore."

The manufacturing technique of firearms has progressed but there have been scarcely any new ideas introduced. The patents registered around 1900 are not only a source of inspiration for every inventor of firearms, but also a source of disappointment—which cannot but increase our reverence for pioneers in the field of fixed-barrel, automatic weapons.



A Source of TNT

Availability and Recovery of Toluol at By-Product Coke Plants

By W. E. Grainger *

OF the various high explosives used in warfare, TNT is the most satisfactory because of its high power and great stability. Trinitrotoluol, commonly known as TNT, is made by treating toluol with nitric acid under proper conditions. Nitric acid can be procured in almost unlimited quantities, but the supply of toluol from its present source is limited and would be insufficient for the production of the necessary high explosives were our country to become engaged in war. Hence, the availability and recovery of toluol is a subject of vital interest to our armed forces.

The commercial sources of toluol are coal gas, carburetted water gas and oil gas, where it is present with benzol and other related aromatic hydrocarbons as a condensable vapor. Other possible sources, as yet largely undeveloped commercially, are: 1. The polymerization of oil gases, cracked gases and natural gas, which is outlined in the November 20, 1935 issue of the *National Petroleum News Magazine;* 2. The Friedel and Crafts synthesis of toluol when a mixture of benzol and aluminum chloride is treated with methol chloride; 3. The hydrogenation of coal which consists of introducing hydrogen into coal substances and into the products of decomposition of the coal under a pressure of about 200 atmospheres and at a temperature of about 450° C. The potential yield from this last source seems to be very important. A few petroleums, including that from California, contain considerable quantities of aromatic hydrocarbons.

The scope of this paper is limited to a description and explanation of the recovery of toluol from coal gas in by-product coke plants. This will involve a discussion of by-product coke plant operation and some characteristics of coking coals.

A COKING coal is a coal of the bituminous rank which, when subjected to destructive distillation, either by itself or in a mixture with other coals of the same rank but of different volatile matter content, will produce a firm porous residue known as coke. For coking in a modern by-product coke plant, a coal must not swell too much on reaching the plastic stage, and must actually shrink in the final stage of the coking operation to facilitate the mechanical operation of discharging. Work done by the U. S. Bureau of Mines has shown that the greatest expansion of coal comes from the part termed anthraxylon, which is the component derived from the woody tissues of plants; and that coals of the least expansion properties are those containing a high proportion of attritus, which is the component derived from the resins, waxes, spores, pollen, cuticules and mineral matter, and in which the bright bands of anthraxylon are embedded. In the Knowles coke-oven process, which is of recent development, the swelling or expanding properties of a coal do not prevent it from being used for coke making.

The marked difference in the constituents of coals of the same rank accounts for the variable yields of toluol and other by-products from the various coking coals. It is known that coals rich in resins, spores, etc., give high yields of condensable aromatic hydrocarbon vapors on distillation.

The prepared coal (crushed and usually mixed) is transferred in charging larries from the storage bins to the coking chambers, which are then sealed with slurry and mud to prevent the infiltration of air and the escape of gases and vapors. These chambers or ovens are usually about 40 feet long, 10 feet high, and 18 inches wide, and take a charge of about 27,500 lbs. of coal. The ovens are arranged in groups or batteries. A common number of ovens per battery is 60, and a battery of these dimensions is capable of producing from 700 to 750 gross tons of coke per twenty-four hours.

The cross-regenerative by-product type of oven is heated with gas from 16-inch diameter fuel mains which parallel the battery on each side below the coking chamber floor. From these mains, 1½-inch diameter leads supply gas to the flues or combustion chambers between the ovens. The fuel gas enters the vertical flues from the horizontal gas duct through removable silica nozzles, where it meets the preheated air from the regenerator and ignites. Combustion takes place alternately at half-hour intervals on the pusher and coke side of the battery. The products of combustion pass up the vertical flues to the top horizontal flue, cross to the vertical flues of the opposite side of the battery, pass down these flues, and out through the regenerator of that side to the waste-gas flue and the stack. In passing through the regenerator a large part of the heat is given up to the brick checkerwork. This heat is absorbed by the incoming air when combustion is reversed by machines which automatically close the fuel-gas cocks on one side of the battery, open them on the other, and reverse the air damper lids. The method and uniformity of heating the ovens have an important bearing on the by-product yields.

In the coking chambers the coal softens and starts to fuse at about 750° F. As the temperature increases the plastic mass hardens, and at still higher temperatures shrinkage takes place, which allows the coke to be easily pushed from the ovens. For a coking time of eighteen hours the temperature in the ovens reaches about 2000° F.

THE gas produced during the carbonization or distillation of the coal rises through ascension pipes, one from the top of each oven, to a collecting main which parallels the battery. This gas is a mixture of fixed gases, vapors of various kinds, globules of liquids held in suspension, and some solid carbon in the form of dust. The principal fixed gases are hydrogen, H_2; methane, CH_4; ethylene, C_2H_4; carbon dioxide, CO_2; carbon monoxide, CO; hydrogen sulphide, H_2S; nitrogen, N_2; and ammonia, NH_3. The principal vapors in the mixture are benzol, C_6H_6; toluol, C_7H_8; xylol, C_8H_{10}; naphthalene, $C_{10}H_8$; carbon disulphide, CS_2; hydrocyanic acid, HCN; solvent naphtha; water; and tar with its phenols. All of these vapors become liquid at ordinary temperatures except naphthalene which solidifies at a temperature of 80° C.

* Assistant Superintendent, By-product Coke Plant, Bethlehem Steel Company, Sparrows Point, Md. Major, Ordnance Reserve, U. S. Army.

This mixture of gases and vapors leaves the collecting main at about 400° C. and is sucked through the primary coolers by the exhausters and thence pumped through the tar extractors, ammonia recovery apparatus and final coolers before entering the light-oil scrubbers. Up to this point most of the tar, ammonia and naphthalene has been removed. In passing through the scrubbers, which consist of a series of cylindrical towers packed with wooden hurdles to facilitate intimate contact, the light oils are absorbed from the gas by an absorbing oil which is passed through the scrubbers countercurrent to the gas flow. This benzolized wash oil, as the absorbing oil is called after passing through the scrubbers or washers, contains from 2.5 to 3 per cent of light oil.

To recover the light oil the benzolized wash oil is heated to about 130° C. and passed through a continuous stripping still, where the light oil separates and passes off as vapor due to its boiling point being lower than that of the wash oil.

These crude light-oil vapors, after being condensed, are washed with 1.5 per cent by volume of 10° Baumé sodium hydroxide to remove the free hydrogen sulphide present in the oil. The crude light oil is then washed in agitators with about .5 per cent by weight of 66° Baumé sulphuric acid to remove the bases and gum-forming resins which form a sludge with the acid. This acid sludge is drained from the bottom of the agitator, and the oil is again agitated with a solution of sodium hydroxide to neutralize the remaining acid. The washed light oil is then charged into a batch still of about 8000 gals. capacity, which consists of a kettle, rectifying column, dephlegmator or reflux condenser, and condenser. Into the kettle of the still with the washed light oil is put about 2 per cent by volume of a 20° Baumé solution of sodium hydroxide to absorb any sulphur dioxide, hydrogen sulphide, or elemental sulphur which may be formed by the disintegration of complex sulphur compounds when heated.

Due to the small percentage of toluol (about 8 to 17 per cent), it is extremely difficult to separate it from the other light-oil constituents in one distillation. It is, therefore, customary after distilling off most of the benzol, to cut out a crude fraction of oil boiling between 95° and 120° C., which fraction should contain all the toluol. This fraction is again washed in agitators with about 5 per cent of 66° Baumé sulphuric acid so as to give it a French Square color test of 4, which is an arbitrary standard selected to show that all of the unsaturated hydrocarbons and gum-forming constituents have been removed. It is again washed with sodium hydroxide to neutralize the acid. This oil, containing a high per cent of toluol, is next charged into a still containing about 1 per cent by volume of sodium hydroxide. In this final distillation a toluol fraction of almost any degree of purity can be recovered. Chemically pure toluol, distilling entirely within a 2° range, includes the true boiling point of toluene at 110.8° C. Most refined commercial toluol distills within a 6° range. The product should be water-white, free from objectionable odor, stable, and contain not more than one-tenth of 1 per cent of sulphur.

THE number of tons of coal carbonized in the United States in by-product coke ovens shows considerable variation, depending of course, upon economic conditions. According to Gluud's "International Handbook of the By-Product Coke Industry" in 1924, forty-nine million tons were thus used; and in 1928, seventy million tons. It is reasonable to assume that in the event of war the steel plants of the country would be running at capacity. This would mean that about eighty-five million tons of coal would be charged into by-product ovens annually.

The amount of refined toluol that could be produced from this amount of coal would depend upon the character of the coal and the conditions under which it was carbonized. Assuming an average yield of 3½ gallons per ton, 297,500,000 gallons of light oil could be recovered. Assuming that 10 per cent of this could be recovered as refined toluol, the amount would be 29,750,000 gallons available for all purposes. From the chemical formulas for toluene and symmetrical trinitrotoluene, the amount of TNT that could be produced from this amount of refined toluol would be approximately 534,310,000 lbs.

SINCE toluol does not exist in coal as toluol, but is the product of the decomposition of certain more complicated hydrocarbon compounds formed during the destructive distillation of coal, there are a number of plant-operating factors, other than the inherent constituents of the coal itself, which have a marked influence on the amount or yield of toluol that can be recovered from a given quantity of coal. Chiefly these factors are as follows:

1. Carbonizing conditions. Very moderate temperatures are required for the best yield of toluol, as it decomposes rapidly between 1110° and 1380° F. Hot oven tops in particular tend to cause degradation of the toluol to carbon and multiple-ring derivatives, chiefly naphthalene and anthracene. Coals containing a relatively high moisture content retard this decomposition, as the steam formed helps to sweep out the toluol vapor and shorten the time of contact of this vapor with the hot surfaces.

2. The temperature of the gas entering the light-oil scrubbers should be as low as possible and should not exceed 30° C. It is desirable to have the absorbing oil about 2° warmer than the gas to prevent condensation of water from the gas into the oil, which gives trouble in the subsequent stages of recovery.

3. The gas should have as little contact as possible with the liquid tar in the train of by-product apparatus preceding the scrubbers, as some of the toluol vapor will be condensed or scrubbed out by the tar.

4. Absorbing oil of good quality should be used in scrubbers designed to give it ample contact surface with the gas. The absorbing medium usually employed for this purpose is a petroleum distillate called from its color "straw oil". A sufficient amount of this oil should be circulated through the scrubbers so as to give not over 3 per cent saturation with light oil.

5. The absorbing oil should be completely discharged of its content of light oil before recirculation and reduced to as small a naphthalene content as possible.

In practice all of the light oil is never completely absorbed from the gas in the scrubbers because the cost of washing out the last traces would be prohibitive. The point of diminishing returns in this absorption operation is reached when about 93 per cent of the light oil is absorbed. This leaves about one-quarter of a gallon per ton of coal in the gas.

In this rather complex industry where toluol is only one of a number of valuable by-products, it is essential that there be a sufficient number of responsible men in the organization who understand at least enough of the fundamentals to know what causes poor yields and how to prevent them.

The Mechanism of Smoke Screens

A Laboratory Analysis of Chemical Obscurants

By Alton L. Kibler *

THE materials most commonly used for the production of screening smokes are white phosphorus, titanium tetrachloride, oleum, chlorsulfonic acid, zinc chloride (produced by burning the HC smoke mixture), and ammonium chloride (produced by atomizing ammonia and hydrochloric acid). All produce white smokes which, in the presence of sufficient moisture in the atmosphere, are composed of liquid particles which are comparatively uniform in size throughout any given cloud. It is the purpose of this article to describe the nature and the behavior of the tiny particles of which these smokes are composed and the mechanism by which they screen objects from view. It is based on a series of experiments which are described in technical detail in the *Journal of Physical Chemistry*, Vol. 35, pages 1074-1090, 1931.

In order that the smoke might be generated under conditions as nearly as possible like those in the field, experiments were carried out in a large air-tight smoke chamber of approximately 63,000 cubic feet capacity and 1000 square feet cross-sectional area. It was provided with ventilating ducts and a large circulatory fan for keeping the smoke uniform in concentration throughout the chamber. The chamber was also provided with facilities for controlling the temperature and for humidifying and drying the air to any degree of humidity desired. The experiments confirmed earlier observations that temperature is a minor factor in influencing smoke particles but that the relative humidity of the air has a great effect on the screening power of smokes.

Smokes were set up in this chamber by dispersing known amounts of smoke-producing agents by means best adapted to the particular smoke being tested. In order to test the effect of relative humidity, smokes were tested in atmospheres containing 60 and 90 per cent relative humidities. At intervals of six, sixteen, and twenty-six minutes after dispersion the observations described below were carried out.

Observations of the obscuring power of the smoke were made through a small window in one end of the chamber upon a black 10-inch disc mounted upon an iron rod four feet above the floor and illuminated by a double row of electric lights. The disc was moved back and forth by means of the iron rod and the distance in centimeters was determined at which the disc was just obscured. Visibility readings were taken at intervals and plotted on a visibility-time curve from which the values used in the work were read.

Particle number was determined by means of an ultramicroscope, to the observation cell of which the smoke was drawn through a short glass tube. The field of vision of the microscope was defined by a small circular aperture inserted in the eyepiece and an accurate determination of the depth of focus of the microscope. The average of fifty successive counts was taken. From the particle count, the depth of focus, and the diameter of the aperture, the number of smoke particles per cubic centimeter was calculated.

Samples of the smoke were taken by drawing a known volume of the smoke through a specially prepared filter mat. The weight of the sample was determined by weighing the filter mats before and after collection of the samples. Great care was exercised to keep the samples at equilibrium with the moisture in the room until after they were weighed to prevent any change in weight due to an interchange of water. The composition of the smoke was determined by analyzing the samples for the chief constituent. From the weight and the composition of the samples the density of the materials composing the smoke particles was determined either by reference to standard tables or by special experimental work.

It is sufficient for the purposes of this paper to discuss the light which the results throw upon the nature and behavior of the ultimate particles of which smoke clouds are composed and upon the mechanism of the screening action of smoke.

In all about fifty smoke clouds were set up and examined. The distances at which the target was obscured varied from about five to about twenty feet. This corresponds to what is usually referred to as dense smokes. The smallest number of particles observed six minutes after dispersion was just under two million per cubic centimeter and the largest number was about nine million. In twenty-six minutes the number usually dropped to between one and two million. The smallest size observed for any smoke six minutes after dispersion was about 0.34 micron (thirty-four millionths of a centimeter) in diameter and the largest size was about 0.95 micron (ninety-five millionths of a centimeter) in diameter. The size of the particles was calculated from the number observed in the ultramicroscope, the volume of air sampled, the weight of the smoke caught on the filter and the density of the liquid composing the smoke particles—assuming that all the particles in any one smoke were uniform in size. In twenty-six minutes the diameter of the particles usually increased by from 10 to 25 per cent of the original diameter.

IT will help to visualize these tiny particles to consider that it would require about three thousand of them laid in a row, touching each other, to reach across the head of an ordinary pin. The same head of a pin would serve as a dancing floor for eight hundred smoke particles, no two of them being nearer each other than the average distance between smoke particles as they exist in the air. This distance is about one hundred times the diameter of a smoke particle. The analogy of the dancing floor is an appropriate one to illustrate also the constant random movements of smoke particles caused by frequent collision with the molecules of the atmospheric gases. If this miniature dance floor with its dancing particles could be enlarged until the particles were as large as members of a children's dancing class, the distance between any two of them would be about a city block. This relatively great distance between smoke particles explains the stability of smoke clouds, since the particles fall out of suspension in air only when they become large enough by collision and adhesion to fall out by gravity. From the above figures it may be seen that in a very dense smoke the particles are relatively as far apart as the earth and the moon.

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ALL the smoke materials used in this work, when dispersed in air containing sufficient humidity, produce liquid smoke particles which are aqueous products of hydration, hydrolysis, or deliquescence of the material dispersed. The water for these solutions is, of course, absorbed from the air by the hygroscopic material of which the particles are initially composed. In the case of the HC smoke candle, white phosphorus, oleum, and ammonium chloride, the particles consist, respectively, of solutions of zinc chloride, phosphoric acid, sulfuric acid, and ammonium chloride. In some smokes, however, other changes in composition occur. For example, analysis of the smoke produced from chlorsulfonic acid revealed only traces of hydrochloric acid which is a product of the hydrolysis of chlorsulfonic acid. For the dispersion of this smoke, chlorsulfonic acid was heated to about 125° C. and atomized by a current of hot carbon dioxide. It was assumed that the heat used in dispersing this smoke together with the heat of reaction with the water of the air was sufficient to drive the gaseous hydrochloric acid from the tiny droplets leaving a solution of sulfuric acid.

The case of titanium tetrachloride smoke presented a difficult problem on account of the complicated chemical reactions which occur between titanium tetrachloride and water. Samples of this smoke were analyzed both for titanium dioxide and hydrochloric acid. It was concluded that the smoke consisted of solutions of titanium hydrate with varying amounts of hydrochloric acid depending on the relative humidity of the air and the time after dispersion. At 60 per cent relative humidity, the composition was fairly stable with time and was represented by the formula $Ti(OH)_4 + H_2O + 0.5$ HCl. At 90 per cent relative humidity, the composition at six minutes after dispersion was $Ti(OH)_4 + 12\ H_2O + 2$ HCl; at sixteen minutes after dispersion it was $Ti(OH)_4 + 7\ H_2O + 1.5$ HCl; and at twenty-six minutes after dispersion was $Ti(OH)_4 + 4H_2O + 0.5$ HCl. The change in composition is due to the loss of both water and hydrochloric acid by evaporation from the particles brought about by changing equilibrium conditions as the reaction between the original titanium tetrachloride and water proceeds.

Special work was required to determine the density of the particles of titanium tetrachloride smoke. Mixtures were made up in the laboratory containing various percentages of titanium tetrachloride and water and these mixtures were analyzed for titanium and their densities were determined. It was found that when the densities of the solutions were plotted against their titanium content, a straight-line graph was obtained. The values of the densities of the particles of titanium tetrachloride smoke were read from this graph.

SMOKE CLOUDS FROM PORTABLE CYLINDERS PROVIDE A DENSE COVER FOR MILITARY ACTION

The obscuring power of all the smokes was greater at 90 per cent than at 60 per cent relative humidity, and, in some instances, this was very marked. This was undoubtedly due to the larger size of the particles at the higher humidity caused by the absorption of moisture. However, in the case of phosphorus smoke, a very greatly increased size of the smoke particles at 90 per cent relative humidity was accompanied by only a comparatively small increase in obscuring power. This anomaly is discussed in the following section of this paper. In the case of ammonium chloride smoke, the increase in obscuring power at 90 per cent relative humidity was very great. We were able to show that ammonium chloride smoke at 60 per cent relative humidity was composed of fine crystals of ammonium chloride, while at 90 per cent relative humidity the particles absorbed enough moisture to become liquid. This change in the nature of ammonium chloride smoke particles occurs at humidities above about 75 or 80 per cent.

THE experimental data gave us a means of estimating rather roughly the amount of water absorbed by the smokes studied. Such an estimate, based on a careful analysis of the data, is shown in the following table. Equilibrium with the moisture in the air is, in all cases but one, reached before six minutes and the values shown represent an average of all observations.

Parts of Water Absorbed by Smokes

Smoke before absorption of water	*Parts of water at 90% R.H.*	*Parts of water at 60% R.H.*
Zinc chloride	3	2
Phosphorus pentoxide	7.5	1
Titanium dioxide	1.5 *	1
Ammonium chloride	5	0.5
Sulfur trioxide (from oleum)	2.5	1
Sulfur trioxide (from chlorsulfonic acid)	5	2

It is interesting to compare the proportions of substance and water, shown in the above table, with the concentrations of similar solutions in bulk at equilibrium with air under the conditions of humidity and temperature which obtained in our experiments. Sufficient information is known with regard to solutions of ammonium chloride, phosphoric acid, and sulfuric acid (applicable to smoke from oleum and chlorsulfonic acid) to make such a comparison possible. The comparison indicates that the same laws of equilibrium which apply to solutions in bulk apply also to smoke particles, although there is a decided tendency for the smoke particles to contain less water than similar solutions in bulk. This is probably due to the well-known fact that the vapor pressure of very small particles is appreciably higher than that for the same liquid in bulk, tending to concentrate fine droplets of solutions.

Since smoke is composed of extremely small particles of liquid (or solid) material in suspension in air, it might be guessed that there is a definite relationship between the obscuring power of a given smoke and the number and size of the particles composing it. We are interested here, however, with the more intimate details of the mechanism of screening. What happens when a ray of light strikes a smoke particle? What is the relationship between the particle number and size and the obscuring power? Is it the same for all sizes of smoke particles? Is the material of which the particle is composed a factor in the obscuring power of smoke? Is one smoke intrinsically a better screening agent than another smoke, or is the difference due rather to differences in the ease or completeness of dispersion or perhaps to differences in the hygroscopicity or other chemical or physical properties of the several smoke agents? These and other questions of a similar nature are answered by the results of this work, quite specifically for white smokes composed of liquid particles, and by analogy for other smokes.

As an aid in comprehending the significance of what follows, it should be stated that ordinary white light consists of ether waves which vary in amplitude or wave length between 0.40 and 0.75 micron—the different wave lengths, when separated, constituting the colors of the spectrum. These light waves pass through transparent objects and are reflected or absorbed by opaque objects. A pane of glass allows the light waves to pass freely, but the same glass, if ground to powder and spread out in a thin layer, forms an opaque barrier to the rays. Similarly, a thin layer of the liquid of which white smoke particles are composed would be perfectly transparent, but the same liquid when broken up into smoke particles and suspended in air forms an efficient obscuring agent.

It was said above that the smallest smoke particles observed six minutes after dispersion were 0.34 micron in diameter, the largest ones 0.95 micron. Of the six smokes tested, only white phosphorus smoke at 90 per cent relative humidity gave particles whose diameters were definitely greater than the longest wave length of visible light. The average of six observations on this smoke extending over twenty-six minutes after dispersion, was 1.03 micron.

THE relation between the obscuring power of a smoke and the number and size of the particles composing it, may be expressed as: The ratio between the sum of the cross-sectional areas of all the particles between the eye and the target, and the area of the target when it is just obscured in the smoke cloud. This was determined by calculating the sum of the cross-sectional areas of all the particles contained in a square prism, one square centimeter in cross-sectional area reaching from the eye to the target, and comparing this sum with one square centimeter of the target as the second term of a ratio. For convenience of terminology this is called the screening ratio.

Not including phosphorus smoke at 90 per cent relative humidity, the average of the screening ratio for all other smokes tested and for phosphorus smoke at 60 per cent relative humidity was 1.24. If several results be omitted which were obviously out of line, due mainly to very small smoke samples, the average ratio would be in the neighborhood of 1.35. For spheres with uniform packing the theoretical ratio for complete blocking out of the background is 1.57. According to a well-known law which applies to human sense perceptions in general, a target will become barely perceptible to the eye when the intensity of light coming to the eye from the target differs by a very small per cent from the intensity of light coming to the eye from a point immediately contiguous to the target. The agreement is sufficiently close to prove that for smoke particles whose diameters are within the range of the wave lengths of visible light, screening is accomplished by a simple blocking of the rays of light. This means that light does not pass through these particles but is reflected or absorbed by them. Since a white cloud appears as a source of diffused light it is assumed that reflection is the principle factor in diverting the light rays.

When smoke particles composed of colorless liquid particles are of such size that their diameters are larger than the longest wave lengths of visible light, some of the light rays pass through them and continue undiverted to the eye of the observer. For such smokes it would be expected that the screening ratio as defined above would be larger than that for smaller particles. This is true at 90 per cent relative humidity, for phosphorus smoke particles, the average diameter of which is 1.03 micron. In our experiments, the average screening ratio for this smoke was 3.86. This explains why phosphorus smoke at 90 per cent relative humidity is little better in obscuring power than phosphorus smoke at 60 per cent relative humidity.

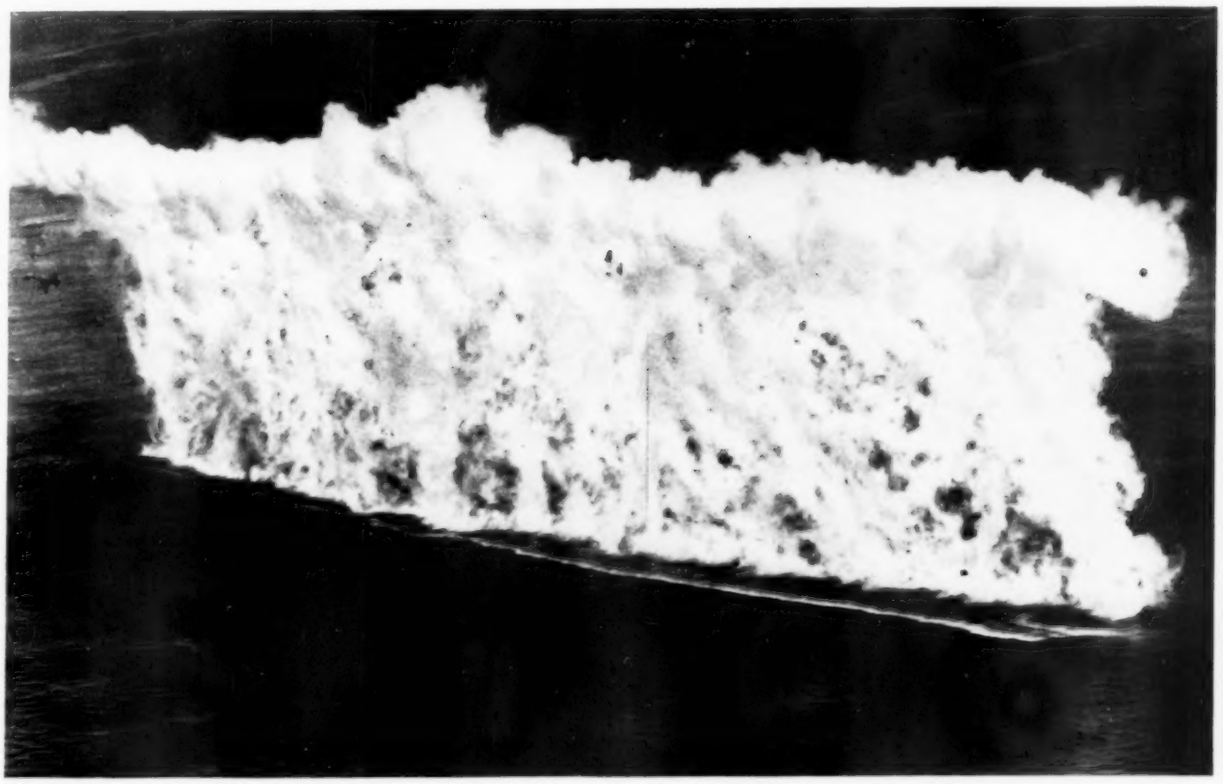
The experimental data obtained during this work enabled a fairly accurate calculation to be made of the efficiency of dispersion for the several smokes tested. The results showed that the efficiency of dispersion is a very important factor in the production of an economical and efficient screening smoke.

* In this case the absorbed water at 6 minutes was distinctly more than at 16 and 26 minutes, and amounted to about 3 parts.

In the following table the efficiency of dispersion is expressed in terms of the percentage of the original smoke-producing substance which got into the air in the form of smoke.

Actual Efficiency of Dispersion of Smokes

Substance dispersed	*Efficiency of dispersion*
HC smoke candle	65 per cent
White phosphorus	80 per cent
Titanium tetrachloride	87 per cent
Oleum	66 per cent
Chlorsulfonic acid	20 per cent
Ammonium chloride	32 per cent



A CHEMICAL CURTAIN DROPPED BY AIRPLANE INCREASES NAVAL DECEPTION AND PROTECTION

The low efficiencies of dispersion for chlorsulfonic acid and ammonium chloride smokes are probably due to insufficient heat to bring about decomposition in the case of the former and incomplete reaction between ammonia and hydrochloric acid in the case of the latter.

IT is clear from the results of this work that the intrinsic efficiencies of all white smokes, composed of liquid particles whose diameters lie within the range of the wave lengths of visible light, are the same. The choice of a suitable smoke-producing agent is determined more by the hygroscopicity of the smoke particles and the efficiency of the method of dispersion than by any inherent property of screening efficiency of the material used. If it were possible to disperse water in the form of fog and prevent the evaporation of the particles formed, the resulting screening efficiency would be exactly the same as it would be for the same number of particles of the same size of any other smoke-producing material. This theoretical conclusion is proved true by the very high screening efficiency of a dense fog when meteorological conditions are favorable for the natural formation of such a fog.

Black smokes are usually composed of particles of unconsumed carbon. The particles are solid and of irregular shapes. Some work was done with black carbon smoke but no definite conclusion could be drawn with regard to the screening ratio for this smoke. The difficulty lay in the impossibility of calculating the cross-sectional area of such particles. It is believed probable however, that black smokes of particle sizes within the range of the wave lengths of visible light, screen by the same mechanism as white smokes. Since carbon is impervious to light the same principle would apply also to particles larger than the wave lengths of light. In carbon smokes the incident light is absorbed rather than reflected as in white smokes and this causes the black color of the cloud.

Colored smokes whose particles are liquid and within the range of the wave lengths of visible light, would undoubtedly obscure by the same mechanism as applies to white smokes. For particles larger than the wave lengths of light, where it might be expected that light rays would pass through them as in the case of phosphorus smoke at high relative humidities, the color of the particles and their index of refraction would be factors.

There is no reason to believe that the principle of the mechanism of screening is different out of doors than in the smoke chamber. There is some evidence, however, that smokes are somewhat more efficient in screening out of doors than in the smoke chamber. If this is true it is undoubtedly due to such factors as the relative positions of observer, smoke and target, to the intensity and reflection of light, position of the sun with respect to the cloud and the observer, and other such causes. The effects of such factors are superimposed on the normal screening effect of the cloud and in no way invalidate the main principles of screening as they have been explained and elaborated within the limits of this paper.

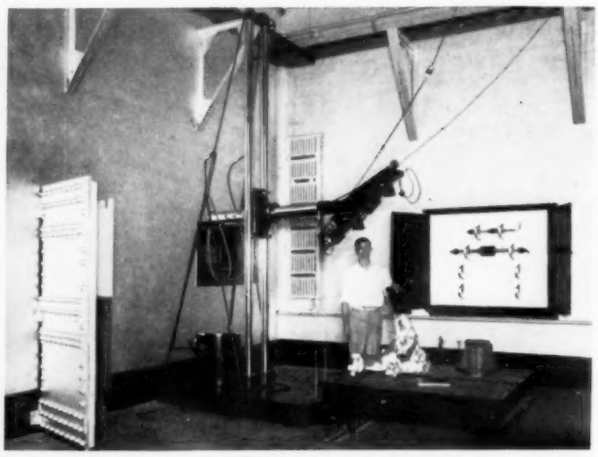
Rock Island Arsenal Laboratory

Current Technique of Ordnance Research and Manufacture

By L. S. Fletcher *

IN the last few years the laboratory at Rock Island Arsenal has grown remarkably and taken on a new significance among the laboratories of the Ordnance Department. It has been necessary to increase the personnel and facilities of this laboratory to a large extent. Its mission is twofold. First, it is charged with basic research into the causes and prevention of corrosion; the investigation of rubber and rubber substitutes; the development of leather, recuperator oils, and cleaning and preserving materials. Secondly, it is a control laboratory for the extensive manufacturing activities of the Arsenal.

The laboratory, which is now housed in Shop M, is divided into the following sections: chemical, physical, metallurgical and X-ray. Each section has the same two types of problems on which to work; that is, research problems and those connected directly with manufacturing duties of the establishment.



RADIOGRAPHIC ROOM WITH TUBE STAND, TUBE STORAGE CABINET AND SPECIAL CAR FOR MOVING LARGE CASTINGS

In connection with the work on shop problems, the laboratory performs the acceptance tests on large quantities of purchased materials, coöperating with the shop inspectors to the full extent of its facilities. This is especially true of the metallurgical section which assists the shop in meeting the requirements of the finished product. The chemical section of the laboratory, with its varied and modern equipment, is prepared to analyze completely any of the metals. In addition, it specializes in the chemical analysis of oils, greases, paints, rubber, rubber substitutes, leather and other materials which go into the manufactured products. The laboratory also assists in the control of the water supply for the Arsenal by making analyses of water taken from the filtration plant and from other points in the Arsenal supply system at frequent intervals.

The equipment of the chemical section consists of the usual standard chemical apparatus, with the addition of some specialized apparatus, such as a life-testing machine, apparatus for cold test on oils, a very accurate constant-temperature bath, electric centrifuge, electrolytic apparatus, Type K2 potentiometer, galvanometer, mechanical convection incubator, etc.

The physical section of the laboratory, with its four Olsen testing machines of 10,000, 50,000, 100,000, and 200,000 lbs. capacity, is well equipped to make all of the physical tests required. The 10,000-lb. machine is a new one, designed principally for the rapid testing of springs. It is a 4-speed machine of latest design, so arranged that accurate readings to less than five pounds may be made. This machine is equipped with a standard curve-drawing attachment and has a special testing head, making it possible to test springs of fifty-five inches maximum length. The 50,000- and 100,000-lb. machines are the standard type. Recent inspections by the Bureau of Standards show these machines to be accurate within eight-tenths of one per cent throughout their entire range. The 200,000-lb. machine has a special length of screw so as to accommodate the piston rod on the 155-mm. G.P.F. gun. These rods are tested in this machine before assembly. The physical laboratory also has a small Charpy impact testing machine and a special piece of equipment consisting of a rack rotating around a carbon arc which, with a humidity cabinet, constitutes an accelerated weathering device. This combination of ultra-violet light and high humidity is used extensively in rapidly testing the properties of many different kinds of protective coatings. It has been found to be a satisfactory accelerated test, particularly for rust-preventive coatings. The normal procedure in using this equipment is to coat a chemically clean plate of polished steel with the coating to be investigated, expose it for five hours to the ultra-violet light rays of the carbon arc and then transfer it for the remaining nineteen hours of the day to the humidity cabinet. Seven days of this test give a very fair indication of the relative protection offered by different coatings.

The physical laboratory is also equipped with the necessary lathes, machine tools, milling machines, drill presses and shears so that all of the laboratory specimens are machined and finished directly under the supervision of the testing engineer in charge of the physical laboratory. This obviates the possibility of any mix-up in steels or any errors which may creep in when these specimens are made in an outside shop by men who are not thoroughly familiar with the manner in which the piece is to be used and the necessity for close attention to details.

THE remaining two sections of the laboratory have been completely built up in the last two or three years. The metallurgical section has the usual equipment for this type of work. It, of course, depends upon the chemical and physical sections for the work which they do. The Arsenal has a new, large metallographic microscope which is equipped with the necessary lenses and camera for work from 10 diameters to 2000

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diameters magnification. The work of this section consists principally in the inspection of incoming material to insure the adherence to specified properties and to assist the shop in solving its problems of machinability, hardenability, distortion, salvage, and such other problems as can best be solved by conference between the mechanical engineer and the metallurgist. This section also has technical supervision of the heat-treating and forging departments. Considerable attention has been paid recently to the question of tool steels. There are on hand at Rock Island Arsenal large quantities of tool steel remaining from the days of the World War. Formerly, considerable difficulty was experienced with the breaking of tools when made from this steel. This difficulty was found to be due to the very poor quality of the steel. Now, breakage has been almost entirely eliminated by a careful check of the material before it is issued. This section is at present investigating spectrographic analysis equipment with a view to having such equipment for the rapid analysis of steels for random elements and for the rapid classifying of steels into their proper alloy group.

STEREOSCOPE, 85 KV DIFFRACTION UNIT AND LARGE METALLOGRAPHIC MICROSCOPE AT ROCK ISLAND

The fourth and newest section of the laboratory is probably the most elaborate of the entire layout. It is the X-ray section. There was recently installed some of the finest industrial X-ray equipment procurable on the market today. This equipment is housed in four rooms having a total length of approximately seventy feet. The rooms are about twenty-five feet wide and, with the exception of the radiographic room, are seventeen feet high. The radiographic room has a 20-foot ceiling.

The southerly room houses the generator equipment which is the Garretson modification of the Villard circuit; and to allow future expansion, is so arranged that the peak potential can be raised by cascading into other transformers. It uses two air-cooled Kenetron tubes to produce full wave rectification of the A.C. supply, to a rippling D.C. potential having a high root-mean-square value. The Villard principle gives a voltage-doubling effect by adding the condenser charge to the impressed transformer voltage, thus reducing materially the problems of transformer insulation. The A.C. supply reaches the primary of the high-tension transformers through an induction-capacity stabilizer, which is one of the salient features of this installation in that it produces a much more stable high-potential supply, which, in turn, makes for a more uniform and more controllable X-ray output. The Garretson modification introduces the center-tap transformer which permits the introduction of current meters at ground potential, and also permits them to be mounted on the control panel.

This generator system has been tested to 450,000-volt output, but inability to secure tested commercial X-ray tubes of this capacity requires that the unit be operated at approximately two-thirds of its rated capacity. This over-capacity, in connection with a 300 KV Benson focus oil-cooled tube, has proved to be a decided advantage in that shorter exposure times than were previously used are now possible in steel sections up to five inches thick. A 4-inch monitor block exposed under very careful blocking technique has shown a resolution of nine-tenths of one per cent on a defect situated one-half inch from the top surface of the 4-inch monitor block. The exposure time was two minutes and thirty seconds at 300 KV and 10 MA. The generator is also equipped with an automatic dissipator so that any charge which remains on the condensers or elsewhere in the unit is grounded when the equipment is not in use.

THE radiographic room, a 20-foot cubicle with a door 12 by 14 feet, has the chrome-plated hollow-tube conductors suspended from its 20-foot ceiling, with several take-offs located so that it is possible to move the tube stand to any position desired within the room. The aërial system includes a standard 250-millimeter sphere-gap with a capacity in excess of 500,000 volts. This sphere-gap is operated by a motor with remote control on the panel board and is used for calibration purposes only.

The tube is carried in a specially designed tube stand which gives a great degree of flexibility. The tube may be positioned anywhere from three to thirteen feet from the floor and has a horizontal motion of six feet. It may be rotated 90° either side of the vertical and the tube itself may be rotated 360° in the tube holders. The entire tube stand is mounted on casters and may be moved easily anywhere within the radiographic room. In this manner it is possible to take exographs of the most complicated castings or of material of any size or shape. Mounted directly on the stand is the cooling unit, which consists of an oil pump which circulates the cooling oil at ninety lbs. pressure through the target of the tube. A pressure valve is connected through a relay, so that if the pressure drops, the current is turned off and prevents damage to the tube. A thermostatic valve is also connected to the main power supply, so that if the temperature of the oil rises above the predetermined temperature set on the thermostat, it also will cut off the current. The oil is in turn cooled by being circulated through a constantly changing supply of cold water at approximately 56° F. from an artesian well near the laboratory.

A track from the craneway comes into the radiographic room. A special car has been built to run on this track so that the heaviest of material may be loaded on the car with the 5-ton crane and then be positioned easily by two men for exographing.

The dark room, which is separated from the radiographic room by the office and control room, is entered by means of a maze and has a developing tank equipped with thermostatic valves in which both the developing and fixing baths

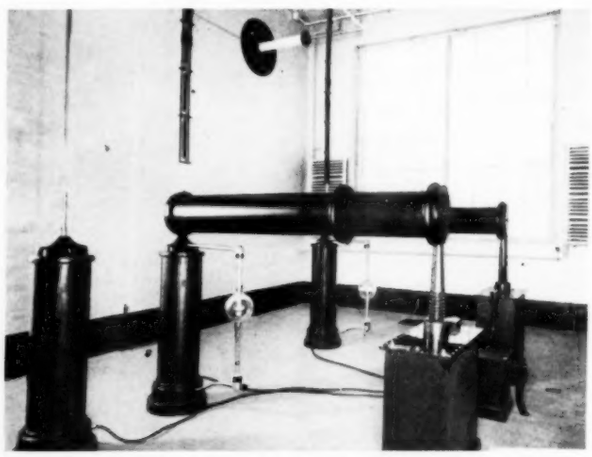
are maintained at a constant temperature of approximately 65° F. The washing water is also maintained at this low temperature. This is particularly desirable during the hot summers which are met with in this locality, as otherwise the double-emulsion X-ray films are very liable to run. The dark room also has an electric drying oven for the rapid finishing of films. This oven is equipped with an electric time switch which is used for film processing when no attendant is present.

View boxes are maintained throughout the plant at those points at which exographs are to be inspected. In the office there is a large stereoscope which is used particularly with the X-rays of welds to give the stereoscopic effect which is very desirable when a weld is being examined or explained to a person not thoroughly trained in the reading of exographs. With this X-ray equipment it has been found possible to penetrate easily 4½ inches of steel showing internal defects of less than 1 per cent; 5 inches of steel with internal defects of approximately 4 per cent; and 5½ to 6 inches of steel, when conditions are ideal, showing defects of 6 to 8 per cent.

DURING the last six months a considerable amount of work has been undertaken in connection with the operation of this unit in the development of the technique applicable to equipment having such a large amount of power. Many interesting things have been developed which have enabled the technicians to use to the best advantage this outstanding installation. For instance, it has been found necessary, in taking pictures of normal-welded structures made of plate from one-quarter to one-half inch in thickness, to use a focal distance of from ten to fourteen feet, with exposure time as short as ten seconds, using the minimum capacity of the 300,000-volt tube which is usually installed in the unit. Using this extraordinary technique, excellent exographs have been obtained without necessitating the changing of tubes.

In connection with this installation there is one unique feature which should be mentioned. The radiographic room does not have the usual lead sheeting for the protection of personnel in the adjoining rooms. When the installation was originally conceived the idea of using concrete walls in place of the lead sheeting was advanced. A careful check of the literature and conference with experts and specialists on the staff of the State University of Iowa indicated that 22½ inches of concrete should be the equivalent of the required three-eighths inch of lead. Conference with the builders disclosed the fact that 24-inch concrete walls could be put up at an increased cost of one thousand dollars over the standard wall construction. The cost of the sheet lead delivered at the site of the building to sheathe these walls would have been five thousand dollars and the cost of installation was figured at approximately twenty-five hundred dollars additional. Since the installation has been completed, extensive photographic tests have been made of the concrete walls without the indication of any X-ray leakage whatsoever. This started a very interesting series of experiments to see if it were possible to obtain the equivalents in protection of concrete and lead. These experiments, thus far, have shown rather surprising results, but they are not yet concluded.

The control room or office contains the above-mentioned stereoscopic view box, which is equipped with rheostat lamp control. It also contains an 85 KV X-ray diffraction unit for research work. The control panel, which is just outside the lead-glass observation window, has an accurate exposure timer, two milliampere meters which can be mounted on the panel because of their position in the circuit at ground potential, the auto-transformer step switches located at the left side of the panel and which permit one hundred increments of voltage control, and the voltmeter which is inserted in the low-potential primary of the high-tension transformer. This method of measuring the voltage necessitates calibration of the arbitrary voltmeter scale against the flash-over voltage of the standard 250-mm. sphere-gap. Below the voltmeter is the filament control rheostat and the sphere-gap control. At the right side of the panel is the main switch and the X-ray tube rheostat switch, together with the magnetic switch and main circuit breaker.



TRANSFORMERS, CONDENSERS AND TUBES IN GENERATOR ROOM AT ROCK ISLAND

THIS laboratory plan has proved to be most convenient under actual working conditions and the performance of the equipment has been a gratification to everyone concerned. The efficiency of the set-up has been remarkable, the time to make an exograph of a given section thickness having been considerably reduced from exposures formerly considered essential. It has been found that from 2½ to 4 minutes is ample time in which to get a clear exograph of sections up to four inches of steel, with a focal distance of approximately thirty inches.

The laboratory is in direct charge of Arthur C. Hanson, a graduate in physical chemistry (PH.D., State University of Iowa). He is assisted by Gerald O. Inman, a graduate in organic chemistry (PH.D., State University of Iowa) and the following graduate engineers: M. P. Christensen (M.E., Colorado School of Mines); Paul C. Cunnick (M.E., University of Kansas); Thomas Rice (M.S., chemistry, University of Louisville, Kentucky); Edgar Horn (B.S., chemical engineering, State University of Iowa); Dillon Evers (M.S., chemical engineering, University of Iowa); David W. Marchant (B.S., electrical engineering, University of Iowa); Cal W. Wulff (B.S., mathematics, St. Ambrose College, Davenport, Iowa); Thomas F. Clark (B.S., chemical engineering, University of Minnesota). Other assistants are: John Robertson, Ray J. H. Cochran, Edwin W. Littig, Ben Grosskopf, Charles Phillips, Miss Alma Martens and Mrs. Elsie Flynn.

The Confederate Medical Department

Its Influence upon War Operations

By Courtney Hall*

STUDENTS of American military history sometimes forget that the conflict of the 1860's was one of the greatest of modern wars. In fact, no military contest to that time can compare with it in the size of operations, the destruction of life and property, and the immense cost to the participants, with the possible exception of the Napoleonic struggle. Battles raged over an area from Pennsylvania to Florida, and from Washington City to the plains of Texas; some four million men took part in it, and estimates of its direct cost, incomplete at best, reach the figure of eight billion dollars.

Consequently, hundreds of cities and villages were destroyed and vast areas of the best agricultural land in the United States were rendered unproductive. Peaceful regions which had never experienced the havoc of war became positions of importance; backwoods hamlets became receiving hospitals for hordes of wounded.[1] A large general and monographic literature has informed us rather fully concerning the military and political phases of the war, particularly from the Northern point of view and recently scholars have begun to attack the associated social and economic problems. Yet from the Confederate side the story has been inadequate, because the South lost the war, and the tendency has been to stress the activity of the North mainly, and that of the South incidently. This is not entirely a matter of prejudice, for valuable Confederate dispatches were lost in the tragic events of the last two years, particularly in the burning of Richmond in 1865. Our monumental publication, the Official Records, contains but three volumes devoted exclusively to Confederate dispatches; likewise the volumes published by the United States Surgeon-General deal mostly with Northern problems.

The disparity in numbers between the contestants, taken in connection with the vastly greater wealth and the resources of the North, make clear that the problem of creating and supplying armies, perplexing enough to the North, was in the end a matter of desperation in the Confederacy. Yet for four years its military machine functioned. Whipped into shape by an able officer personnel, it contested on more than even terms for two years all efforts to subject the new government. Especially difficult was the effort to a region which lacked manufacturing facilities in great amount, and the capital to develop the needed industries in time to win a victory. Chief among the problems which had to be faced by the Confederate staff officers was that of securing adequate medical aid for their men.

On February 26, 1861, the Confederate government created by law a general staff for the army; there were to be an adjutant- and inspector-general, a quartermaster-general, a commissary-general, and a surgeon-general, with their respective staffs. The tentative nature of this law is indicated by the fact that only ten surgeons were provided for, to assist the surgeon-general, though another clause indicated that as many additional assistant-surgeons as were later thought necessary by the War Department, could be added to that number.[2] As the head of this important department, President Davis designated Doctor Samuel Preston Moore, of Charleston, South Carolina. Born in 1813, Moore had graduated from the Medical College of South Carolina in 1834, and was next year appointed assistant-surgeon in the United States Army, with the rank of captain. For twenty-six years, almost to the outbreak of the war, he performed service in a variety of difficult posts: in Mexico, in the lower Mississippi valley and in several western Army posts. For his Mexican War service, he was promoted to full surgeon, with the rank of major. When called to head the Confederate medical service, he was practicing medicine in Little Rock, Arkansas. His biographers, among them members of his own staff, have attested to his soldierly qualities, the strict discipline which he always maintained, and his modesty as to his own achievements. Likewise they have praised his ingenuity and energy in building up and maintaining a vast organization.[3]

THE story of the achievements of Moore and his staff would extend this paper beyond its allotted length; how he assembled a corps of 2500 surgeons and assistant-surgeons, in addition to about 100 naval surgeons; how he administered a vast network of hospitals, including one which was the largest military hospital in the history of warfare; how he secured supplies of drugs by smuggling them through the lines or by running them in through the blockade; how he prepared and caused others to prepare medical botanies and surgical guides for the use of medical men and set up laboratories and distilleries in the interest of the department; how he organized a society of military surgeons to circulate among all the staff the valuable information acquired, and established a journal for summarizing the progress of Confederate medical knowledge; how, most impressive of all, his department cared for some 3,000,000 cases, a number more than three times as great as the entire Confederate personnel, to say nothing of the 250,000 prisoners of war, who were generally hospital cases. From his inadequate headquarters at Richmond, he administered his scattered staff of medical men with the field armies and in the hospitals, together with a large number of matrons and nurses, hospital attendants, laboratory and distillery personnel. As regular routine, the officers at Rich-

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1. T. L. Livermore, "Numbers and Losses during the American Civil War," passim; F. Phisterer, "Statistical Record of the Army of the United States," 10; R. H. McKim, "Numerical Strength of the Confederate Army," 21; Nicolay and Hay, "Abraham Lincoln," Vol. X, 339. A more detailed study of the subject under discussion appeared in *Medical Life*, September, 1935, pp. 443-508 by the author of this paper.

2. O. R., Series IV, Vol. 1, 114-115.

3. The actual date of Moore's appointment is somewhat doubtful. One writer states it as November 7, 1861, following the resignation of a temporary incumbent, Dr. De Leon; but as early as July 30th of the same year Dr. Moore was designated in dispatches as "acting surgeon-general" and in a summary of the principal officers of the Confederate War Department his appointment is stated to have been March 16, 1861, and no mention is made of any predecessors. O. R., Series IV, Vol. 1, 508, 1176. On Moore's personality, see, E. R. Wiese, "Samuel Preston Moore," in *So. Med. Jour.*, Vol. XXIII, 916-923; S. E. Lewis, "Doctor Samuel P. Moore," *So. Hist. Soc. Papers*, Vol. XXIX, 278; *Richmond Times-Dispatch*, May 15, 1910.

mond received and answered thousands of dispatches, some from the civil and military authorities at the capital, some from their agents in Europe or along the military frontier, others from the medical directors of the armies in the field and of the various military hospitals. New hospitals were opened, others were closed, supplies were requisitioned, medicines purchased and shipped, arguments carried on with the military men over hospital personnel and as to furloughs for convalescent soldiers. Such was something of what it meant, to a single department of the Confederacy, to wage a long war with a powerful foe. The President of the Confederacy said of their work: "It would be quite beyond my power to do justice to the skill and knowledge with which the medical corps performed their arduous task." [4]

Such was the problem and its difficulty. It is worth while inquiring somewhat more concretely what military effects were noticeable from this great achievement in organization which has been briefly described. Of course it is true that the medical department of the Confederacy was of far more importance than merely to hustle from the field of action the disabled men. In that, as in every modern army, the general physical welfare of the troops was mainly the care of the doctors; they oversaw the sanitary provisions and the water supply, and attended to the men's minor illnesses; many of the leading surgeons influenced, as staff members, the successive maneuvers of the detachment. Such routine matters alone were enough to keep them busy, even in the shrunken commands of Lee, Jackson or Bragg.

As it was the commanding officer's duty to lead a detachment into action, and to conduct it, if possible, to the military advantage of the Confederacy, so it was the chief medical officer's grim and painful duty to clear up the battlefield. The engagement won or lost, he became the most important individual of all, for upon his coolness and the efficiency of himself and staff depended the success of pushing an advantage, or of accelerating a retreat. Sometimes it depended upon the medical men whether a group would ever again function as a military organization. Colonel Henderson has well shown how important to the success of Jackson in the Valley was the speed and dispatch of the men under Doctor McGuire, his chief surgeon.[5]

EQUALLY important to the success of the military arm was the service performed behind the lines in the receiving hospitals and in the general hospitals to which the badly wounded and the dangerously ill eventually came. If these men could be returned to the front by a quick hospitalization, the Confederate cause would be, by that much, assisted. When we realize that the war was fought, on the Southern side, largely by volunteers, the importance of hospital replacements becomes more evident. To illustrate what success the Confederacy attained in this matter, let us examine briefly the organization set up on Chimborazo Hill, near Richmond.

This hospital, one of some twenty-three maintained in or near Richmond, was not only the largest in the Confederacy, but exceeded in size any in the history of warfare to that time. It contained 150 well-ventilated single-story buildings, each, one hundred by thirty feet, arranged in five divisions, to serve the respective needs of the men from Virginia, Georgia, Alabama and the Carolinas. Each building formed a ward and contained from forty to sixty beds. Between the pavilions were neat alleys and streets, and a staff of one hundred surgeons and nurses was in attendance. The entire organization, with its patients, medical men, nurses and guards, formed a military post under the command of the hospital director, Dr. James McCaw. Professional apothecaries were in attendance; there was a good water supply and sewerage system; there were five ice houses and a bath house on the grounds. Furniture for the hospital was made in several converted tobacco factories nearby, and a loyal Virginian, Mr. Stearns, devoted the produce of his large dairy farm to the soldiers' needs. On the James River and the Kanawha Canal plied the Chimborazo trading packet, bartering in Richmond, Lynchburg and Lexington for supplies. This fine organization functioned for three and one-half years, treated 77,000 patients and returned more than 70,000 of them either to their homes or to the front.[6]

Such was the story, in lesser degree, in most of the other hospitals in Richmond and elsewhere: in the hospital supported by Sally Tompkins, the only female commissioned officer in the Confederacy; in Howard's Grove Hospital; in the Winder Hospital; in General Hospital No 1; in the Charlottesville General Hospital, which utilized the buildings and many of the faculty of the University of Virginia; in the great Tishomingo Hospital at Corinth, which utilized the large hotel of that name—in these and many others, good surgery was performed, lives were saved, and man power trickled in a never-ending stream back to the gaunt and battle-scarred regiments of the leaders.

Hospital conditions were naturally better in Richmond than in other centers, for it was near staff headquarters, and had the advantage of better transportation facilities than most places. The Winder Hospital compared very favorably in size and general facilities with that at Chimborazo, for it had a capacity of 4800 patients, covered 125 acres, and also had its own ice houses, dairy and bakery. The production of the latter was so great that excess bread was sold to the prisoners at Belle Isle and Libby. Though no such organizations as the Sanitary Commission existed in the South, yet a number of smaller ones like the Georgia Relief and Hospital Association functioned well. The official sources and diaries of the period abound with tributes to the unselfish women of all classes for their aid to the sick and wounded.[7] The Confederate Congress voted large appropriations to the work of the hospitals, one such—in its appropriation bill of May 1, 1863—being the largest single item on the list.[8]

It is quite true that on certain occasions the medical facili-

4. J. Davis, "Rise and Fall of the Confederate Government," Vol. 1, 310; W. B. Blanton, "History of Medicine in Virginia in the Nineteenth Century," 272-275; "Medical and Surgical History of the War of the Rebellion," Vol. II, Part 1, xxi; O. R., Series 1, Vol. XXXIII, Part 1, 1196-1197; same series, Vol. XVII, Part II, 749; same series, Vol. LII, Part II, 532; Series III, Vol. III, 154; Series IV, Vol. 1, 114-115, 209-212, 408-409, 601-602, 604-605, 794, 1041, 1095-1097; S. P. Moore, "Resources of the Confederacy in Feb. 1865," S. P. Porcher, "Resources of the Southern Fields and Forests;" S. P. Moore, "Standard Supply Table of the Indigenous Remedies for Field Service"; E. R. Wiese, op. cit. 917-920; many items in the Confederate Museum, Richmond, Virginia.

5. W. B. Blanton, op. cit. 277, 280, 281-283, 287; G. F. R. Henderson, "Stonewall Jackson and the American Civil War," Vol., I, 260-261; O. R., Series 1, Vol. II, Part II, 387, 633-634; same series, Vol. V, 389; Series IV, Vol. I, 369-373, 1151.

6. W. B. Blanton, op. cit., 301-302; E. R. Wiese, op. cit., 920; J. R. Gildersleeve, "History of Chimborazo," passim.

7. J. F. Rhodes, "History of the United States," Vol. V, 464-465; Resolution of the Confederate Congress, Statutes at Large, April 11, 1862; Kate Cumming, "A Journal of Hospital Life in the Confederate Army of the Tennessee"; Matthew P. Andrews (compiler), "Women of the South in War Time"; W. B. Blanton, op. cit., 302-308.

8. Confederate Statutes at Large, Provisional Congress, 38, 39, 46, 115; same, First Congress, 63-64, 95, 139.

ties broke down completely. Such was the case after Lee's repulse at Malvern Hill, and it was true in the other heavy campaigns. But it is likely that no blame should be attached to the medical staff members for this condition. Doctor Guild, medical director of Lee's Army, found himself after the above battle with a mass of wounded, both Federal and his own men, whom he could not move; he was without anaesthetics and drugs and was not in communication with the headquarters in Richmond, but these conditions were the result of a week of terrific slaughter and of such rapid maneuvering as to confuse the best of staff officers. Despite the disorganization of the department, General Lee commended Guild and many of his subordinates in general orders for their conduct during the Seven Days.[9] That there was careful planning to avoid a repetition of this condition is evident in the care with which Doctor Guild worked out a system of receiving hospitals along the Orange and Alexandria Railroad in June, 1863, preparatory to the campaign about to be fought in the North. Difficulties of transportation, however, militated against the best care of the wounded in that campaign, for General Lee decided that it was impossible to carry into Northern territory hospital units like Richmond Ambulance Corps.[10]

The military code of the time seemed to demand the presence upon the battlefield of general officers, and the casualities among them were exceedingly high; battle wounds disposed of Albert Sidney Johnston, J. E. B. Stuart, and Stonewall Jackson and came very near cutting off the careers of Joseph E. Johnston, ranking field officer in the first part of the war and that of General Longstreet, Lee's best corps commander after Jackson's death. The narrow escapes of Lee himself, and of President Davis, who often galloped out from the city to inspect an engagement, are known to all. With the code of honor of a Southern gentleman, even a good medical department was frequently powerless to deal. Had not Jackson and his staff been mistaken for Federal cavalry, as they galloped out in the dusk of Chancellorsville to reconstitute the Confederate lines, and furthermore, had not one of Jackson's stretcher bearers been struck down, thus giving the General further painful injuries, how different a story might be the later history of the war! As it was, he lingered a week, after expert surgery, to succumb finally from pleuro-pneumonia of the right side. On such slender threads did the success of the Confederacy depend; all the medical men could do, in such cases, was to labor to offset the damage which had already, unfortunately, been done.[11]

AS in most modern wars, disease was the most formidable enemy with which the Confederate Army had to contend. In the Army of Northern Virginia, for example, each man suffered from, on the average, three reported illnesses from July, 1861 to March, 1862, while of the 77,000 patients received during the war at Chimborazo, 50,000, or nearly two-thirds, were sick and not wounded. The men suffered from malaria, typhoid, tuberculosis, smallpox and measles. A badly balanced diet swelled the ranks of scurvy cases, and diseases of the throat and lungs appeared when the troops moved into cold climates or when they were imprisoned in the bleak Northern concentration camps. Diarrhea, colic and indigestion ravaged the camps, particularly where a good water supply was lacking, or where the medical order to discard the fry pan for the stew pan was not enforced. The physicians worked frantically to offset these bad conditions; they sought supplies of food which would help the men combat the scurvy, as vinegar and potatoes; detachments of men were sent to search the woods to gather sassafras, wild onions, artichokes and other antiscorbutics.

Upon the ability of the medical department, wrote Doctor Guild in January, 1863, to combat dietary insufficiency, might depend the success or failure of Lee's next campaign. With this conclusion General Lee was in accord; in his letter to Secretary Seddon in April, 1863, he stated that the daily ration of his men was sufficient only to keep them alive and was useless in preparing them for heavier exertions. Connected with malnutrition in the army were the efforts of the surgeon-general to circulate guide books among his staff to assist them to secure native foods and medicines of tonic value. So too, did the seven laboratories set up to prepare medicines for the medical staff, combat this evil. Great scientific skill was utilized in conducting these units, the laboratory at Charleston being under the direction of the famous Le Conte brothers. The distilleries which the medical department operated to provide an alcoholic medium for new medicines as well as to manufacture whiskey for hospital use, were opposed by several of the states, there being a feeling that too much of the small grain supply was thus consumed.

IN addition to conducting his Association of Army and Navy Surgeons, and his *Confederate States Medical and Surgical Journal,* the valiant Doctor Moore found time to project several elaborate studies of disease as it existed in the Confederacy. One such study, that of Doctor Jones on hospital gangrene, occupied over 400 pages in the Surgical Memoirs of the Sanitary Commission, a Northern publication. The problem of the prisoners and their diseases was the subject of another exhaustive study by the department. Complaints in great number by Federal prisoners were dealt with, often personally, by the surgeon-general, and such information as he could gather from paroled surgeons as to the condition of Confederates in Northern prisons, he carefully forwarded to his superiors for use in their negotiations with the North.[12]

But all such difficulties are no doubt minor ones when we consider the scope of the conflict and the inexperience of the officials of the Confederacy in conducting war on a large scale. From a considerable mass of information we will gain the impression that the medical department functioned well, when we take into account its scanty means. Without the strenuous, almost desperate endeavors of Moore and his doctors and nurses, no such resistance as was put forth would have been possible. If, as has been well said, Jackson was the strong right arm of the high command in the Confederacy, and Jeb Stuart the keen eye of its military intelligence, may we not suggest that the medical department provided the means and skill by which not merely the arms and the eyes, but the entire Confederate organism continued to function?

9. O. R., Series I, Vol. II, Part I, 633-634; same, Part II, 537.
10. W. B. Blanton, op. cit., 281, 282-283.
11. G. F. R. Henderson, op. cit., Vol. II, 450 seq.; W. B. Blanton, op. cit., ch. 13; D. S. Freeman, "R. E. Lee," Vol. II, 533, seq.; Hunter McGuire, "Account of the Wounding and Death of General Jackson," in *Richmond Medical Journal,* May, 1866.
12. O. R., Series I, Vol. XXV, Part II, 687, 744-745; J. B. McMaster, "History of the United States," Vol. IX, 335-336; J. W. Jones, "Treatment of Prisoners in the War between the States," 156-158; same author, "Medical and Surgical Memoirs," Vol. II, 395-419; O. R., Series I, Vol. XXI, 1084-1085; Series II, Vol. VII, 557; same series, Vol. III, 698; same series, Vol. IV, 782-783; same series, Vol. VI, 181; same series, Vol. VII, 499.

ARMY ORDNANCE

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Month by Month

MORE and more in the minds of thinking people the possibilities and requirements of adequate air defense are coming to the fore. It is well that this is so because no problem of national security is quite as vital as the proper appraisal of air power. There is no overstatement of value in the suggestion that air policy as determined today may be the deciding factor in any future national emergency. We are brought to these conclusions by happenings of recent months.

Air Defense

Abroad we have witnessed the first major use of air power in modern warfare. In the last issue of this Journal Maj. Gen. J. F. C. Fuller, distinguished for his military leadership, his thinking processes and his writing ability, gave an eye-witness account of the conduct of the campaigns in the Italo-Ethiopian War. We believe this study as published in Army Ordnance was the first analysis to appear in our country by a qualified military observer of the new strategy and tactics in Abyssinia. General Fuller described unusual combat uses of aircraft—as had been anticipated—but he also narrated how an army corps, 20,000 strong, was advanced 120 miles on a 6-days' march, and how this huge unit was *entirely provisioned by squadrons of airplanes!* General Fuller summarized his study by expressing the conviction that in another major war "the decisive weapon will be the airplane."

At home we have seen important steps taken to strengthen our military air arm. New equipment in goodly quantity is being provided, changes have been made in organization to strengthen the G.H.Q. Air Force, and the efficiency of the Air Corps has been advanced by a change in promotion of personnel. New blood in the form of young reservists who will serve in the Corps will be taken in. The ordnance function, which is an armament responsibility of the first magnitude, is being pushed as energetically and as effectively as limited facilities permit. Parenthetically, may we observe that the Ordnance Department too needs more officers—and it needs them badly. We will have more to say on this score later.

All these and other occurrences, at home and abroad, are indicative of a reawakened sense of air power. We are on the threshhold of developments in organization, technique and matériel, the application of which in years to come can be decisive for our national well-being. Who knows but that progressive steps already taken point definitely to a much wider and more fundamental conception of air power? Disregarding the voluminous and passionate discussions of years past, it would seem that progress points to an ultimate decision as to whether air power, military power and naval power are substantially equal, each to the other. If the equality exists, then the conclusion is inevitable that any reasonable type of defense organization must recognize it. The question is worthy of most serious consideration in the light of the future rather than of the past. The worst thing that could happen to any defense organization would be that it face the future confident that the past is the only guide. True, the past has its immutable lessons but air power with all its unknowns bids fair to revolutionize combat as radically as did the advent of gunpowder. So we suggest that if power in the air is coequal with power on land and on sea, then recent happenings should cause us to look to it and face it squarely. What has been done thus far is along lines of our adopted military policy and every student of our national defense will await the results with sympathetic, though not hidebound, interest.

DESPITE the generous sums provided for active-duty training of reserve officers during the coming fiscal year, we understand that no provision has been made for any increase in the allocation of these funds to provide training for Ordnance reserve officers. Recently it was said that one in three of all reserve officers would be trained during 1937, but we have seen no indication that the ratio holds for the Ordnance Reserve. On the basis of past years, rough calculation shows that only one in about ten Ordnance reserve officers will receive active-duty assignment during the next year. In other words, it appears that under present War Department policy some eighty per cent of training funds is allotted to the combat arms while only twenty per cent is allocated to the technical branches.

Training for Technical Reservists

To our way of thinking this policy is extremely short-sighted and indicates a survival of the old concept of munitions power in relation to man power. We had not thought heretofore that the error of this sort of outlook need be shown to our own War Department. But apparently some officials are still laboring under the delusion that the two elements of national defense—men and matériel—bear an 80-20 relationship!

Granting the great need for a tactically trained reserve to supplement our Regular Army and National Guard, there is a much greater—or an equally great—need for training those officers whose emergency assignments have to do with the design, production and supply of ordnance. The best plan in the world for the mobilization of man power will be defective indeed if the mobilization of munitions power is not commensurate with it. And it will not be commensurate if another emergency finds our reservists trained tactically but not technically. There is no more reason to believe that a qualified mechanical engineer engaged in his profession in civil life can assume his technical duties in time of war with

proficiency if he is not adequately trained than there is to believe that our trained man power can perform its emergency job with broomsticks for rifles, semaphores for signal communication and Greek fire for chemical warfare. The World War proved the point conclusively.

Current training policy in this respect is out of joint and it will not be remedied if matériel power is looked upon as secondary to man power. We urge the War Department to revamp its present allocation simply because ordnance is still the crux of our national defense. Without technical reserve officers trained regularly and efficiently in the technique of ordnance production and supply we will blunder along in another emergency and at worse cost in life and money than ever before. Whatever the technical training ratio may be at present, it is decidedly inadequate—so inadequate, indeed, that it sounds as though the gentleman who thought a million men could spring to arms overnight, might have formulated it.

BRIG. GEN. TRACY C. DICKSON, whose name is a byword among all members of the Ordnance family, died suddenly at his home in Haverford, Pa., May 17, 1936, in his 67th year. The announcement came as a shock to his many friends of the Army Ordnance Association and of the Army, who through years of friendship and professional contact regarded him as one of the leading ordnance authorities of our times.

BRIG. GEN. TRACY C. DICKSON

Born at Independence, Iowa, General Dickson was graduated from the United States Military Academy in the class of 1892. After two years of service as a lieutenant of Artillery he was commissioned in the Ordnance Department. His career coincided with a transition period in design and manufacturing technique of our principal matériel. His first service with the Department was as assistant to the Commanding Officer at the Springfield Armory. He was assistant to the Commanding Officer at the Rock Island Arsenal from 1899 to 1902. As a captain of Ordnance he was stationed in Washington for four years following, serving as recorder for the board of officers which recommended the adoption of the Springfield rifle, model 1903, and also of the board appointed to test automatic machine guns. As a major he served for four years, from 1906, as assistant to the Commanding Officer of the Sandy Hook Proving Ground and as a member of the Ordnance Board. From 1910 to 1914 he served on the staff of Maj. Gen. George W. Goethals in the Canal Zone, receiving his promotion to lieutenant colonel in 1912. In 1914, upon his return to the United States, he assumed command of the Sandy Hook Proving Ground and was appointed a member of the Board of Engineers for Testing Rifled Cannon. At his own request he was retired from active service in 1915 with the rank of colonel. The following year, however, he was assigned to active duty at the Watertown Arsenal and served on the board which recommended the adoption of the Browning machine gun. He was in command of the Watertown Arsenal from March 17, 1917, to the end of that year.

In January, 1918, he was placed in charge of the Control Bureau, Office of the Chief of Ordnance, later again assuming command at Watertown. By virtue of his service at the Panama Canal he was honorably discharged in 1919 as a brigadier general. But in 1920 he again returned to active service to serve for the following twelve years at Watertown.

General Dickson achieved fame for his metallurgical developments in the field of gun construction. Under his direction metallurgical investigation and technique, the development of the laboratory at Watertown and especially the advancement of methods for casting guns were carried through to a point of perfection reflecting great credit upon his genius and upon the Army. It is not an over-statement of the case to say that our present practice of gun-making is due in large measure to the guidance of General Dickson. For this his memory will be cherished.

We republish here, in part, a tribute which appeared in these pages two years ago, written by an officer who had served under General Dickson. It symbolizes the man and his mark of authority—his famous cane:

"General Dickson is recognized as a man of genius and achievement. His talents need no repetition here. His cane is almost as widely known, but its story remains hidden. It should be told for the benefit of posterity.

"The early history of General Dickson's cane is shrouded. It is probable that the General himself is uncertain as to its origin. Upon its first appearance at the Watertown Arsenal it was variously reported to be of formidable proportions, of solid ebony, to be of great weight, etc. With the passage of time the stories became more confusing and Bunyanesque, particularly after the second or third telling. To some it possessed the properties of Aladdin's lamp, so quickly was the result accomplished after a wave of this cane directed the effort. It was an allotropic symbol. One day it was a cudgel, to rend the air or smite the floor with swish and echo, adding emphasis to the forceful expletives of its owner. Another time it was a scepter, fasces or talisman, representing all the authority of command, enunciated by vigorous thrusts and parries in the proximity of the subject. At times it was a giant scribe, used to draw large-scale designs on the earthen floor or other substance capable of receiving its mark. . . .

"In accordance with law, General Dickson was retired from active duty in 1932. The General, exercising that less well known sentimental side of his make-up, retired his cane at the same time. His last act at the Watertown Arsenal, as its commanding officer, was to lay this cane upon his desk and remark that he felt that it belonged to the arsenal. The arsenal felt the same way and gladly accepted this symbol of authority. It now reposes over the picture of its owner in the office of the commanding officer.

"It was a bit disillusioning to see this pair separated, and to be permitted to examine the less conspicuous member at close range. A tradition has been shattered by this separation! Upon close inspection the cane was found to be of light wood, stained and varnished, well worn and the glossy surface broken and chipped here and there. The ferrule was worn and split. The ivory-tipped handle, inlaid with bits of silver, showed the marks of wear, caused by incessant gripping with a strong hand. As one holds it, it does not appear to have extraordinary powers. One has a feeling of reverence, but not of power. The separation of this historic pair has scattered the magic; it is like beholding Damon without Pythias, Romulus without Remus, Haig without Haig. Apart from its owner, it is no longer a symbol of power, it was just a cane—General Dickson's cane."

Whether General Dickson's cane remains for all time at Watertown or not, his memory will linger there in years to come as a monument to his service as engineer and administrator in carrying on gun-making in the United States.

The Nationalization of Munitions, II—Today

An Editorial

IN the first of this series of editorials, published in the May-June issue of this Journal, emphasis was placed upon what we called "background" of the proposal for the nationalization of munitions production. We made clear that every sane human being has a sympathy for and patriotic desire to participate in any practical plan which aims to make the recourse to war less frequent as an instrument of national policy. We endeavored to show that nationalization of arms production is by no means a new panacea but that it has made its appearance from time to time over many years; that the subject was thoroughly studied and rejected when the United States was on the brink of the World War in 1916, and that practically all qualified military and civilian students of the armament question since that time have opposed any nationalization scheme either as a peace-time or as a war-time measure. We quoted the opinions of outstanding Americans, men of commercial disinterestedness, who by experience are competent to pass judgment on the question and whose views, we believe, are worthy of soundest consideration. Arrayed against these experts of the past twenty years there are today a few vociferous and, we believe, not unbiased opponents. Chief among them is a little bloc of United States Senators aided and abetted by a very talkative but very shallow group of alleged peace peddlers of domestic and foreign vintage.

To the opinions of these groups and their followers who favor government ownership of all arms-producing facilities, full faith and credit ought to be given despite many evidences that are challenging. But we are not concerned here with the personalities of munitions demonology. Rather we shall proceed to a discussion of accepted national policy regarding the manufacture of armament, taking as examples the practices of our own United States and Great Britain. Other countries, with the exception of Russia, might be cited just as easily. Of course in Russia today the arms industry is nationalized—as are all other industries. Russia does not prove the point one way or the other except to show that if we are going to have nationalized munitions as against private manufacture we too will have to have it in all branches of industry or in none. The choice between nationalization and private production of munitions is actually the choice between communal and private property.

WHEN one listens to the demagogues' rantings about the evils of the private manufacture of arms, the listener is led to believe that this nefarious business is a secret, undercover kind of thing that nobody knows anything about. Because the demagogue knows little or nothing about it and does not seem to want to know, the man on the street is led to believe that nobody else knows anything about it either. In our country, as in other countries that have professional armies, one of the major responsibilities of government is the duty to provide for national defense. Trained personnel study all angles of the situation constantly, even though their studies are not of the sensational kind to make headlines for political purposes. It would be a severe indictment, and an entirely unfounded one, to assume that officers of our Army or those of any other army are out to undermine their own national defense. Of course they are not intent on undermining anything and only a political profiteer would be so naïve as to raise the question.

In addition to the data cited in the first editorial of this series, our own Government, following the mandate in the National Defense Act of 1920, has endeavored constantly to attain an adequate degree of armament preparedness. Indeed the National Defense Act was written with the experiences of the World War fresh in mind. Yet our Defense Act and similar legislation of other democratic countries—except Russia—have never undertaken seriously and permanently to prevent the private manufacture of arms. The reasons why this is so are, of course, not far to seek. In a word, nationalization of the arms industry logically means the nationalization of all industry and we are back again to the same choice between communal and private property. But put it down that no modern government based on the rights of private property has yet adopted peace-time nationalization of munitions.

Our own War and Navy Departments have not only urged, year in and year out, since the World War and before it, the absolute necessity of a private industry trained and equipped for the production of armament, but quite logically they have tried their best to develop this industry to a maximum peace-time potential. Realizing, as everyone must who has the slightest conception of the arms problem, that there are at best very few private firms engaged exclusively in the manufacture of completed military weapons, our War Department has constantly urged a program of "educational orders" for no other reason than that there might be a group of producers in our midst who by peace-time experience would have some of the basic knowledge required for making ordnance in time of war. Obviously if there were in the United States an adequate peace-time munitions industry worthy of the name, educational orders, as sponsored by our War Department, would be a contradiction in terms. In 1933—long before the Senate Munitions Committee was thought about—our War and Navy Departments, after years of study, issued an industrial mobilization plan which was described fully in these pages. It is a sound and sensible statement of policy which reflects great credit upon both Departments because it epitomizes our munitions experience of generations. Yet nothing in that plan recommended the nationalization of munitions production. Any mobilization plan cannot be static; it will be revised from time to time to meet changing conditions. As future revisions of the plan are decided upon, we venture to predict that at no time will they demand a nationalized munitions industry. When in the first version of our present Neutrality Act the exportation of arms and implements of war was regulated in accordance with plans originally sponsored at Geneva in 1925, no one was so childish as to propose the prevention of private munitions production. *Regulation is quite different from nationalization.* We now have regulation under the so-called Neutrality Act of 1934; to go further would be simply to undermine our own national defense.

Thus we in the United States have had for years an excellent plan of industrial mobilization, a very meager peace-time arms industry and an unsuccessful effort to obtain peace-time educational orders for arms production by private industry. And we have the regulation of exports of implements of war.

NOW we can observe what another country is doing in this regard—a country whose culture and tradition are not far different from our own. We refer to the munitions policy adopted by the government of Great Britain. In the White Paper which recently announced the new armament program for Great Britain, all that we have done *and more* are made national policy. Our daily press gave many columns to the program for the increase of the Army and Navy of Great Britain but said little about the industrial preparedness part of the program. This was only natural. Our press and people do not worry about armament production which is the very essence of national defense. They think of flag waving, drum beating and marching men as the way to win wars. And when war comes these same good folks seem to think that howitzers grow on trees, that tanks are to be had for the asking and that ammunition in the finished state can be purchased at the corner chain store, wrapped in wax paper, with full instructions to shake well before using. These same good people are usually horror-stricken when they learn that it takes from six to eighteen months and even longer for a great industrial nation like our own to produce its weapons of defense in quantity. They wonder why the delay and why the cost. And when our manhood is slaughtered in the interim because the weapons cannot be brought into existence, other investigating committees are appointed, again with politicians at the helm, to find out why the system has broken down. This is the American cycle of national defense!

But to get back to Great Britain's sensible program. The British White Paper enunciates the following policy on munitions production. We quote at length:

"MODERN war conditions involve a vast expenditure of munitions and equipment, and in the early months of the Great War there was a tragic loss of life in consequence of the lack of adequate reserves. If we are to avoid a repetition of that tragedy in any future war and to provide by our preparations an increased deterrent, we must prepare ourselves either by accumulating immense reserves or by so organizing industry that it can rapidly change over at the vital points from commercial to war production should the necessity arise. The first alternative, however, is only feasible within limits, and beyond that is ruled out not only on account of its cost, but because weapons and methods of warfare are continually changing, and these accumulated reserves might therefore well become obsolete before they were required. His Majesty's Government, therefore, have returned to the second alternative, and they have already taken some preliminary steps toward putting it into operation. Our present sources of supply are the Government factories and the normal Government contractors, who, in peace, manufacture various types of armament. The Government factories are chiefly responsible for a specialized kind of output which is generally nonexistent elsewhere. This includes the production of explosives and propellants, the filling of shells and cartridges and the manufacture of fuzes, bombs, mines, and torpedoes. To meet present requirements in these categories it will be necessary to extend or duplicate existing Government factories, and both vulnerability of site and the needs of the Special Areas will receive consideration.

"The normal Government contractors supply warships, aircraft, artillery, machine guns, tanks, lorries, and miscellaneous stores of every description. They also supply a great variety of articles for export and home consumption and for both purposes they subcontract for materials, fittings, and stores. To some extent it will be possible for them to contribute to the increased output required by extending their plant or workshops. But in the course of investigation it soon became apparent that, even for the purpose of the peace-time program, the field would have to be extended to other firms not normally engaged in armament work, and at the same time it was clear that this extension would to some extent assist in the establishment of the organization necessary to insure rapid expansion of production in time of war.

"In connection with the approved program for the Royal Air Force, steps are already being taken to extend the field of production by placing orders with firms who do not ordinarily manufacture for the Force or for civil aviation. This process of extension will have to be further enlarged to meet the programs for the Navy and Army, but even so, something more will be required.

"IN order satisfactorily to provide for our needs both in peace and war, His Majesty's Government have decided to create a reserve source of supply which would be available in case of emergency. The method of procedure contemplated is to select a number of firms who do not normally make warlike stores but who are suitable for the purpose by reason of their experience and their possession of a skilled staff of engineers and workmen. Arrangements would then be made with these firms for the laying down of the necessary plant and machinery for a given output of selected articles and sufficient orders in peace time would be guaranteed to allow of the requisite training in the work of production. The particular circumstances will vary in connection with every firm and with different types of product. Wide elasticity of arrangements must therefore be provided for, but the underlying principle is that each selected firm, while maintaining and developing its normal civil trade, will agree to use its organization and commercial structure to set up some measure of munition production and thus create the reserve source of supply.

"There remain two other important features of the Government's plans for the organization of production which must be mentioned.

"The first concerns the supply of skilled labor, for which there will necessarily be a largely increased demand. In some of the skilled occupations there is already noticeable the shortage inevitable when large and sudden demands are made upon labor supplies after a period of depression. It will be for the industries concerned, with such guidance as the Government can give, to make sure that vital processes are not held up for want of the necessary craftsmen.

"The second point concerns costs and prices. His Majesty's Government are determined that the needs of the nation shall not serve to pile up extravagant profits for those who are called upon to meet them. They are confident that industry as a whole has no desire to exploit the situation, and, indeed, they have already received satisfactory assurances from the Federation of British Industries of their readiness to collaborate. But when regular contractors are required to work nearly to their full capacity on Government orders, and when large numbers of firms are asked to undertake work which is new to them and which will have to be produced on equipment of which they have had no previous experience, the ordinary methods of contracting do not offer adequate safeguards that prices bear their proper relation to actual costs.

"His Majesty's Government have given much time and thought to this matter and they have been materially aided by the experience gained during the last few months by the Air Ministry working under conditions of exceptional pressure. On the one hand, it is important to retain the good will of industry, for in peace time firms cannot be compelled to undertake contracts on terms which they consider unreasonable. On the other hand, difficulties are bound to arise in dealing with so many and such various sources of supply, where there are not only contractors, but also subcontractors and sub-subcontractors concerned. There will be new problems where firms require financial assistance in order to lay down new plant and hold it at the Government's disposal, and these cases will be particularly urgent, since until they are met it will not be possible to make a start. It will be necessary also to coördinate the demands of the three Services so that proper priority shall be observed and competition between them, which might lead to higher prices, avoided.

"His Majesty's Government believe that all these difficulties can be overcome through the organization they have in mind. As regards the principal contractors, contact will be made with them by the Service Departments, while in the case of subcontractors in secondary or ancillary sections of organized industry, it is intended that communications shall pass through small committees to be appointed by the trade organizations themselves. Control to prevent excessive profits will be effectively exercised by inspection of books, adequate technical costings, audits on behalf of the State and arbitration in cases of dispute. The Government are satisfied that this can be done without impairing the confidence and enterprise of contractors undertaking novel and difficult tasks.

"Coördination of Service requirements will be effected through the existing Principal Supply Officers Committee Organization of the Committee of Imperial Defense, and the new Deputy Chairman of the Committee of Imperial Defense will as Chairman of this Committee be able to supervise the whole system of supply and correct any deficiencies that may be found to arise.

"Treasury control will, of course, be maintained throughout the whole field. It will be important, however, to see that the work is not delayed by the over-elaboration of financial safeguards, and new methods of procedure are being worked out which will insure the effectiveness of financial control without impairing the continuity of progress."

THIS is good common sense. It appeals to common-sense people because it is realistic and practical. The good sense of this policy and the nonsense of our senatorial policy of nationalization have brought forth appropriate comment. *The Canadian Defense Quarterly,* published the following editorial résumé of the new organization of industry and man power in Great Britain:

"It will be noted from the foregoing that the new arrangements contemplated are intended to serve two purposes, namely, to provide improved and strengthened machinery for the consideration of defense problems as a whole, and, secondly, to insure the fullest and most effective use of the nation's industrial capacity and man power available for the production of war material.

"The latter problem is a dual one. In the first place it is of the present and calls for the ability to carry through in a limited period of time, and without impeding the normal course of trade, measures of peace-time rearmament which will make exceptionally heavy demands upon certain branches of industry and certain classes of skilled labor. Secondly, it is of the future and concerns the necessity to organize industry so that it can fulfill war-time requirements.

"In order to satisfactorily provide for needs in peace and war, the British Government has decided to rely, in the main, on private industry. A number of firms will be selected who do not normally make warlike stores, but are suitable for the purpose by reason of their experience and the possession of a skilled staff of engineers and workmen. Arrangements will be made with these firms for laying down the necessary plant and machinery for the given output of selected articles and sufficient orders in peace time will be guaranteed to allow the requisite training in the work of production.

"A wide elasticity of arrangements must, of course, be provided for, but the underlying principle is that 'each selected firm, while maintaining and developing its normal civil trade, will agree to use its organization and commercial structure to set up some measure of munitions production.' Such firms will, to some extent, assist the government factories and the existing munitions industry in producing the requirements for the peace-time program. But their main function is to provide a reserve source of munition supplies which would be available in case of emergency."

THOSE of us in the United States who have watched and urged the development of industrial mobilization planning these eighteen years since the World War doff our caps to our British cousins for this latest evidence of national good sense. They go us one better, and in one fell swoop adopt educational orders while some of our ruralistic and unrealistic statesmen ask us to take nationalization. The Nye Committee spent over $190,000 of the tax-payer's money on its so-called investigation. There have been varying estimates of what, if any, value was received. Senator Carter Glass, after he delivered a famous philippic defending the memory of President Woodrow Wilson against attacks by the chairman of the Committee, and when refusing more funds to the Committee said, in his judgment the committee investigation represented public funds wasted. We are inclined to place a slightly higher value on the work because the Committee tactics have brought home to press and people the shallow, political self-seeking of a great deal of the enterprise. For example, the Louisville *Courier-Journal* expressed this view:

"The recommendation of the Nye Munitions Committee, or rather of a majority of that committee, that the Government take over the facilities for the construction of all warships as well as the manufacture of all weapons and ammunition is another ill-advised proposal of that body prompted by the obsession that the munitions industry is the world's public enemy No. 1. The plan is one way to take the profits out of war, but it is also a sure way to take the victory out of war should the United States be involved in some future conflict. Every such proposal in the past has been denounced as suicidal by Army and Navy officials, both of this country and of Great Britain.

"As a private enterprise the munitions industry has developed the weapons of war and high explosives. Its research chemists are working constantly for new ideas and new products for war and peace-time uses. Untrammeled by politics and the waste and inefficiency of Government ownership, it constitutes a highly efficient working organization and a

vital necessity in time of national peril. Its destruction would be a blow to America's defense and security.

"The minority of the committee takes a similar view. 'If large Government plants are erected to provide these commodities,' it declares, 'there will be inevitable local political pressure to maintain them at full capacity production regardless of defense needs.' Government ownership, it points out, would leave the country without 'adequate corollary reliance through private manufacture.' And it emphasizes the fact that 'unless these facilities are kept on a full-time production basis during peace years, the unit cost of production greatly would exceed that of private purchase.

"The munitions industry cannot be defended for its evil practices of the past. Its profits in war time have been considerable. Regulation is the solution in the first instance; taxation in the second. There is no valid reason for Government ownership and operation of all such plants. There is every reason against it—preparedness and security."

The Saturday Evening Post gave this well-founded analysis: "Historians will set their own valuation upon the prolonged inquiries of the Senate Munitions Committee, but the recommendation of a majority of the committee in favor of complete peace-time nationalization of what are commonly known as munitions of war raises serious doubts. In case of war, private manufacturers must be relied upon to supply the bulk of such material, and they can hardly be expected to do this without experience in times of peace. Evils have grown up in connection with the sale and export of munitions, and it is proper that such dealings should be consistent with policies of the State Department. There can be more rigid control of munitions without the evils of complete Government monopoly.

"A minority of the Senate Committee believes that with the extension of Government munition plants there would be inevitable local political pressure to maintain these plants at full capacity, regardless of actual defense needs, and the result would be to encourage rather than to discourage armament. Moreover, with no private manufacture in times of peace, the minority believes that adequate provision for war cannot be made unless the 'nationalized facilities are maintained at a needlessly extravagant and dangerous rate during peace time.'

"The minority also believes that costs to the Government would be higher than would be the case if part of the material were available through normal private purchases.

"When we consider Russia and Italy, it is difficult to see how the nationalization of munitions will make for peace. If Senate committees wish to propose the nationalization of all industry or the elimination of all profits, that is their privilege. But when, by two years of ballyhoo, they get people into the frame of mind of imagining that the sale and export of munitions constitute an important cause of war, they are doing a real disservice.

"Powder makers did not cause the American Revolution or the Civil War. Italy did not conquer Ethiopia, Russia and Japan do not threaten each other, Japan did not conquer Manchuria, Germany does not threaten Europe because of munition makers. Nor were such manufacturers responsible for the World War. All this agitation in regard to munitions raises distinctly false hopes; it leads people to believe that war can be prevented by a mere device, that peace can be bought like a patent medicine, or given to us by an act of legislature. As W. Armin Linn wrote in *The Saturday Evening Post* three years ago: 'Peace exists in spirit . . . War, perhaps more than any human malady, results from a state of mind. Disarmament agitation has . . . developed a race of armament dyspeptics. People sit around, finger on pulse, worrying how soon the martial blood pressure will carry them away. The specter of war and armaments is ever being paraded before us. Quiet and confidence have been replaced by phobias and fads.' "

IN our judgment Mr. Linn in the above quotation expresses the essential note which must underlie every discussion of every phase of war and peace—the manufacture of armament included. Our armament dyspeptics, as Mr. Linn labels them, are only placing additional obstacles in the road to peace when they seize upon alleged evils as being basic. It takes only the intelligence of a child to distinguish between use and abuse, between cause and effect. No serious-minded person can long hold to the belief that our munitions problem should be solved via the prohibition complex. The error of this dyspeptic reasoning was demonstrated in no uncertain terms when hysterical reformers inflicted the Eighteenth Amendment upon a free people.

But nationalization goes further than any antiliquor movement ever dared to go: it is a sure way of reducing our national effectiveness if war should ever come. Proponents of nationalization tell us that we could eradicate what they say are evils incident to private manufacture by reserving to the state exclusive production of armament in time of peace. In the same breath they tell us that in time of war private industry would be utilized. We wonder what these good people actually believe the problem of ordnance production to be when they disregard the most obvious lessons of recent history. The record of the World War, despite the glorious achievement of private industry, is replete with cases running into the thousands where the time required (*after war began*) to train personnel, build and procure machine-tool equipment, adapt drawings and specifications to particular facilities, build the new facilities required, handle the myriad problems incident to so great an undertaking—all these and others meant delay sometimes of six months, oftentimes a year and longer, in getting the job under way. Here again the would-be reformer disregards Mr. Linn's correct analysis when he forgets that delay, from whatever cause, must be paid for at a terrific price. Every minute lost in the ability to produce the weapons of defense in time of war must be paid for not in dollars but in the blood of our manhood. Worse still, the ultimate price for such folly might very well be national defeat. We sometimes think that the blatant attitude of the nationalization propagandists reveals an anxiousness for that very thing—defeat for the cause and the arms of the United States should they ever again be asserted.

And so our second analysis of the nationalization of munitions would have this conclusion viz., that nationalization is a suicidal proposal however you look at it. It is suicidal economically in time of peace because it is a step toward communal and away from private property. It is suicidal strategically in time of war because it is a step toward defeat and away from victory. In the concluding editorial of this series, which will be published in the next issue, we propose to present a factual rebuttal of the reasons advanced in some quarters for taking arms production out of private hands. After all, as an essayist said recently, "It is intelligence, not sentiment, that will give us world peace". (*To be concluded.*)

Association Affairs

Los Angeles Chapter

LOS ANGELES entered the list of cities where local chapters of the Army Ordnance Association are established when the Los Angeles Post was inaugurated on May 27, 1936. Sixty-two members were present for the ceremonies which began with dinner at the University Club. Mr. Earl B. Gilmore was elected President of the new organization and accepted its charter which was presented on behalf of the Association's President, Brig. Gen. Benedict Crowell, by Capt. Ralph Cook Scott. Seated at the speakers' table with Mr. Gilmore were Dr. Robert A. Millikan, Lt. Col. Walter P. Boatwright, Col. Halsey E. Yates, Dean F. W. Hinrichs, Mr. R. L. McCourt, Mr. E. P. Querl, Capt. Philip Schwartz, and Lt. Col. J. H. Pirie.

MR. EARL B. GILMORE
President, Los Angeles Post, A. O. A.

Captain Schwartz, Ordnance Officer at March Field, was instrumental in organizing the new chapter. Before the election he stated the purpose of the meeting and called upon the Nominating Committee for its report. In addition to Mr. Gilmore the other nominees presented by the Committee were: for Vice-President: Mr. Donald Douglas; for Secretary: Captain Scott; and for Treasurer: Capt. Samuel K. Rindge. The following gentlemen were nominated to serve as Directors of the new chapter: Lt. Col. W. H. Adams, Milo A. Baker, Maj. Ralph O. Cragin, H. S. Hitchcock, Lt. Col. M. M. Mitchell and M. A. Koffman. All nominees were elected by unanimous vote.

Mr. Gilmore read telegrams and letters of congratulation from the Secretary of War, Hon. George H. Dern; from the President of the Army Ordnance Association, General Crowell; and from the Chief of the San Francisco Ordnance District, Mr. Samuel Kahn. There were five principal addresses. Doctor Millikan, Nobel prize winner and distinguished physicist of the California Institute of Technology, spoke on the need of accurate knowledge in ordnance design. On the very day of the meeting, he said, he had a conference at which the subject under discussion related to a fundamental investigation of the action of materials under sudden shock. Little is known about the subject, Doctor Millikan said, and empirical rules of thumb are in general use by engineers rather than exact knowledge. This he applied to the technique of ordnance design. He began his remarks by pointing out that people who preached pacifism usually had some strange quirk about them and were not pacifistic at heart. They were, he thought, the type of individuals who take sides strenuously, and frequently become so-called pacifists because they do not sympathize with the side on which their own country might be fighting.

Colonel Boatwright, representing Maj. Gen. William H. Tschappat, Chief of Ordnance, began his remarks by reading a letter of greeting. He described advances made in the design and production of ordnance material, stressing the importance of time, trained personnel and facilities for the manufacture of ordnance, especially at the beginning of a national emergency.

Colonel Pirie, acting Commander of the 1st Wing, G.H.Q. Air Force, in the absence of General Clagett, spoke on the relationship of ordnance design and production to aircraft performance. He stated that too frequently the proper consideration had not been given to solving the difficulties which arise when airplanes are equipped with ordnance. He cited instances of the past where the airplane was designed and built and then the weapons were hung on it in convenient places. The result was that in some airplanes gun and bomb control were so placed as to confuse the personnel. He expressed the opinion that ordnance must be given full consideration if airplanes are to be utilized to the maximum as satisfactory fighting machines.

Mr. Querl gave a detailed description of the growth of industry in and about Los Angeles. He referred to the tremendous untapped sources of raw materials, both chemicals and metals, and pointed out the important relation of these materials to the national defense.

Mr. Morton Anderson, the next speaker, was a member of the Symington Anderson Company which produced large quantities of gun and ammunition forgings during the World War. Mr. Anderson described the difficulties facing the private manufacturer in time of emergency and applied very practical lessons to the conduct of ordnance manufacturing procedure.

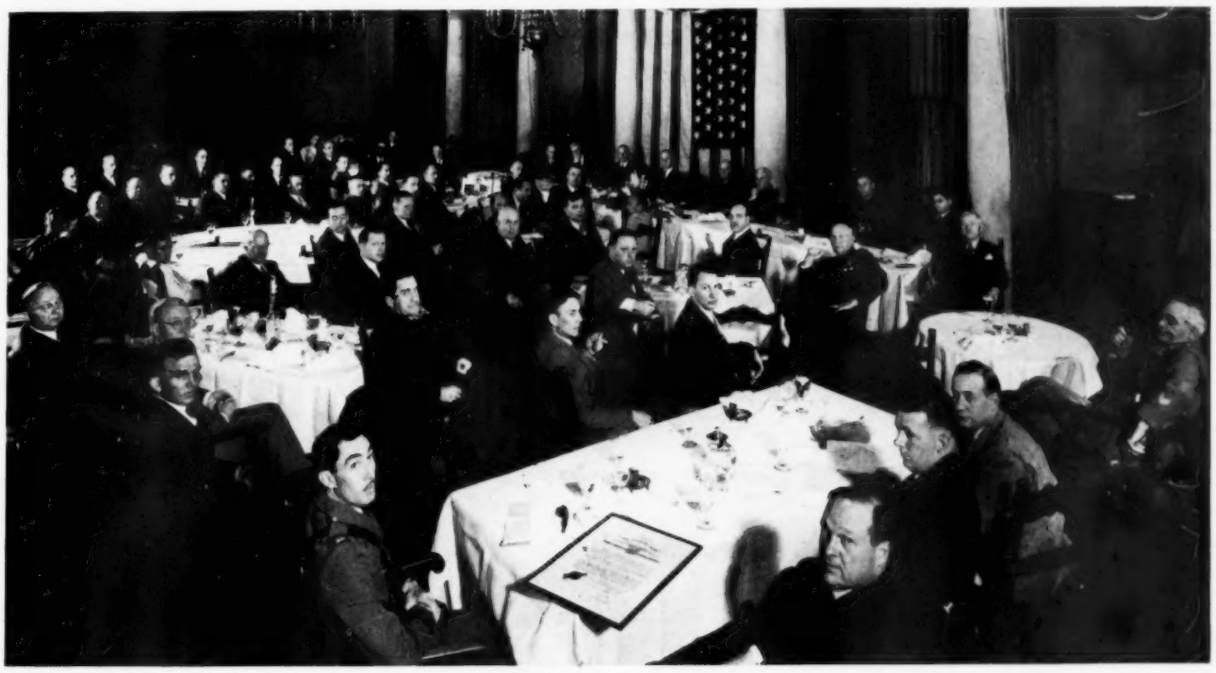
The following biographical sketch of the new President of the Los Angeles Chapter is published by way of introduction to the general membership of the Association:

Mr. Earl B. Gilmore is a native of California, born February 17, 1887, in historic Casa La Brea, which his father, Mr. A. F. Gilmore, had acquired with dairy ranch lands from the old Spanish rancho La Brea, now largely incorporated in the City of Los Angeles. He attended high school in Hollywood, and it was during his course there that his father discovered oil on the dairy ranch, thus shaping the son's career. While learning the oil business, he also attended Stanford University, class of 1913. The death of his father followed upon his university work and the task of operating the oil company devolved upon him. He accepted the responsibility with characteristic energy, launching a successful expansion program that eventually established the business throughout the Pacific Coast states.

He has always taken an active interest in public affairs—especially those concerning safety—and served as Police Commissioner in Los Angeles (1927-1929). The traffic safety record established by the drivers of his own company is one of the best in industry. An ardent sportsman, anxious over conservation of wild life, he has served as California State Fish and Game Commissioner under appointment from Governor Rolph.

Of athletic stature and inclination, a basketball and football player in his school days, Mr. Gilmore is a devotee of outdoor sports and outdoor life. As an outgrowth of this enthusiasm, he erected and operates the Gilmore Stadium with capacity for 20,000 spectators at a corner of his old dairy ranch, now surrounded by metropolitan Los Angeles. He has always made his home at Casa La Brea or a nearby residential section of Los Angeles.

ARMY ORDNANCE, on behalf of the entire membership of the Association, extends congratulations to the officers and their associates who organized the new Los Angeles Chapter and thanks them for their active interest. This, the twelfth local chapter of the Association, is assurance that ordnance preparedness in the United States is progressing toward a more general understanding; its sponsors and members are rendering a distinct service to the national defense. The territory of the new chapter embraces the counties of Southern California (including San Luis Obispo, Kern and San Bernadino and all south thereof) and the states of Arizona and New Mexico. All active and prospective members of the Association resident in this area are eligible for membership in the Los Angeles Chapter.



INAUGURAL DINNER, LOS ANGELES POST, MAY 27, 1936, UNIVERSITY CLUB, LOS ANGELES, CALIF.

NOMINATING COMMITTEE

THE biennial election of officers and three of the national directors of the Association will be held in accordance with the Constitution and By-Laws by letter ballot, polls closing 12 o'clock noon, September 1st. The President of the Association has appointed a nominating committee consisting of the following: Brig. Gen. Samuel McRoberts, Col. Jere. Campbell, Lieut. Col. Wm. Carter Bliss, Mr. E. A. Russell and Mr. Roland L. Oliver. The nominations will be submitted in due course and ballots will be forwarded to all members on or before July 31st.

The election will include the offices of President and two Vice Presidents, all of whom will serve for two years beginning January 1, 1937, and three directors for a four-year term.

NEW YORK POST

THE annual election of officers of the New York Post, Army Ordnance Association, was held on May 10th with the following results: President: Samuel McRoberts; 1st Vice-President: H. B. Machen; 2nd Vice-President: F. W. Roller; 3rd Vice-President: J. E. McNary; 4th Vice-President: W. B. Updegraff; Secretary: H. K. Rutherford; Treasurer: A. H. Skinner; Executive Committee: the Officers and John Ross Delafield, L. D. Booth, Crosby Field, C. O. Gunther, Hoffman Nickerson, James L. Walsh and Chas. Elliot Warren. The nominations had been submitted to the members by a committee consisting of General Delafield, chairman, and Cols. L. D. Booth and H. K. Rutherford.

ARMY ORDNANCE ASSOCIATION SCHOLARSHIP KEYS

AT the Military Convocation, University of Oklahoma, the Army Ordnance Association scholarship keys were awarded to Ralph L. Hock and Nathan B. Chenault, by President William Bennett Bizzell. Mr. Hock, of Oklahoma City, is taking the chemical engineering course and Mr. Chenault, of Wichita Falls, Texas, is a student in petroleum engineering. Senior Ordnance students who received awards were: Alden W. Suderman, Commanding Officer, Honor Battery, first semester; Wade A. Eskridge, Commanding Officer, Honor Battery, second semester, and Marion C. Dorney, outstanding ordnance senior. The Convocation address was delivered by Maj. Gen. Robert U. Patterson.

The following Ordnance graduates have recently been commissioned as second lieutenants: Willard Anderson, William R. Clarke, William G. Davis, Jr.; Marion C. Dorney, Wade A. Eskridge, Harold Feldstein, Delbert L. Haynes, Glenn N. Houston, Charles C. James, Francis S. Livermore, Allen L. Mosey, Alfred H. Schmidt, Jr., and Alden W. Suderman.

Capt. Jacob G. Sucher, Ord. Dept., is the Ordnance Officer on duty with the R.O.T.C. Unit at University of Oklahoma.

The scholarship keys at Massachusetts Institute of Technology were awarded to Charles R. Holman and John H. Gander—both members of the Ordnance Unit of the Advanced R.O.T.C. Mr. Holman, a senior, is Battalion Adjutant of the Third Battalion. Mr. Gander, a junior, has been selected as acting officer on the Regimental Staff.

Student Colonel Herbert H. Borden, Ordnance Unit, was the recipient of one of two gold medals awarded by the Massachusetts Society of the Sons of the American Revolution for outstanding accomplishment in both the military and academic requirements for the Advanced Course, R.O.T.C. Mr. Borden, who was president of the M.I.T. Chapter of the Army Ordnance Association during the past year, was also designated an honor graduate in accordance with Army Regulations. The awards were presented by Dr. Karl Taylor Compton, President of the Institute, at a review of the entire R.O.T.C. held in his honor. Lieut. Col. O. J. Gatchell, Ord. Dept., is on duty with the Ordnance Unit at M.I.T.

At Lehigh University keys were awarded to Frank J. Biondi of Bethlehem, Pa., a senior in chemical engineering, and to William G. Turnbull, Jr., of Philadelphia, Pa., a junior in mechanical engineering. The presentation was made at the ninth annual field day of the Military Department. The exercises consisted of military ceremonies, competitions and the award of prizes won by members of the R.O.T.C. and of the University rifle team during the school year. Among those present were Maj. Gen. A. J. Bowley, Commanding the Third Corps Area; Dr. Clement C. Williams, President of the University, and Maj. J. O. Green, Jr., Professor of Military Science and Tactics at Lehigh. Maj. T. C. Gerber, Ord. Dept., is the Ordnance Officer on duty with the Ordnance Unit at Lehigh.

At Georgia School of Technology, Atlanta, keys were presented, in the senior class, to Cadet Capt. Julian T. Smith, Ordnance Unit, of Elberton, Ga., named this year as outstanding

Co-Op student; and in the junior class, to Cadet Sgt. William A. Lindstrom, Ordnance Unit, of Benton, Ark. The presentation was made by Maj. Newton H. Strickland, Ord. Dept., during Military Honors Night. Major Strickland, Ord. Dept., is on duty with the Ordnance Unit.

The scholarship keys at Cornell University were awarded to Harrison P. Baldwin, Mechanical Engineer, 1936, of Erie, Pa., and to Andrew S. Schultz, Jr., Bachelor of Science in Engineering, 1936, of Wellesley Hills, Mass. Both are seniors in the Ordnance Unit. The presentation was made by Dr. Livingston, President of the University, at the President's Review. Capt. Merle H. Davis, Ord. Dept., is the Ordnance Officer on duty with the R.O.T.C. Unit at Cornell.

Lieut. Col. Edwin A. Shepherd

LIEUT. COL. EDWIN A. SHEPHERD, a charter member of the Army Ordnance Association, died at his home in Washington, D. C., May 16, 1936. For many years prior to the World War he was a civilian employee in the Ordnance Department at the Sandy Hook Proving Ground. By reason of his great familiarity with small arms and small-arm ammunition, he resigned his civilian status and entered the employ of the Remington Arms Company at Bridgeport, Conn. At the beginning of the World War he was commissioned a captain in the Ordnance Department and was assigned to finance and procurement activities of the Small Arms Division, Office of the Chief of Ordnance. Early in 1918, when the Procurement Division was formed, he was assigned to the Small Arms Section of that divison. In March, 1919, he was honorably discharged from the Army. Early in 1922 he was appointed Controller of the United States Shipping Board where he installed auditing and accounting systems. Later he transferred to the Veterans Bureau from which he was retired three years ago.

Colonel Shepherd was well known to members of the Association and particularly of the Washington Post. His interest in the national defense was always an active one and his friends in the ordnance cause, with which he had been identified for so many years, will long remember their capable and kindly associate.

New Members

THE following have recently been admitted to membership in the Army Ordnance Association: Wallace S. Badger, Washington, D. C.; Milford Baker, Upper Darby, Pa.; C. A. Birkebak, Detroit, Mich.; E. John Brandeis, Pacific Palisades, Calif.; E. H. Brown, Wauwatosa, Wis.; Geo. L. Buffington, Detroit, Mich.; F. W. Cederlead, Detroit, Mich.; Charles E. Chapel, Norfolk, Va.; J. F. Christoff, Milford, Del.; R. B. Criddle, Detroit, Mich.; Victor E. Edwards, Wilmington, Del.; Albert H. Emery, Stamford, Conn.; J. K. Fulks, Detroit, Mich.; L. W. Grothaus, Milwaukee, Wis.; Phil Huber, Detroit, Mich.; Robert W. Knight, Seneca Falls, N. Y.; John Leafstrom, Philadelphia, Pa.; Ivar Lindberg, West Allis, Wis.; H. C. Merritt, Wauwatosa, Wis.; John Miljan, West Los Angeles, Calif.; Maurice M. Mitchell, Los Angeles, Calif.; John C. Moore, Midland, Mich.; T. M. Olson, Detroit, Mich.; Carl R. Quellmalz, San Francisco, Calif.; Stuart M. Salisbury, Los Angeles, Calif.; A. Lynam Satterthwaite, Wilmington, Del.; I. J. Snader, Detroit, Mich.; Charles F. Squibb, Paris, France; Richard Stanton, Hartford, Conn.; Lawrence L. Stout, Darlington, Wis.; Floyd L. Strawn, Fort Bragg, N. C.; O. H. Wetherby, San Gabriel, Calif.; F. E. Whittenburg, Los Angeles, Calif.; William F. Wise, Detroit, Mich.; N. A. Woodworth, Detroit, Mich.; S. S. Yeaton, Quantico, Va., and W. E. Yunker, Springfield, Ill.

Necrology

NOTICE has been received of the death of the following member of the Association: Lieut. Col. James S. Smyser, Ord. Res., Quincy, Mass. To his relatives and friends, Army Ordnance, on behalf of the Association membership, extends condolences.

Communications

Ordnance of the Confederacy

The Editor:

The article which appeared in January-February Army Ordnance, "Ordnance of the Confederacy, Notes of Brig. Gen. Josiah Gorgas, Chief of Ordnance, C. S. A.", contains a reference to the effect that "in field artillery the production was confined almost entirely to the Tredegar works in Richmond".

The Official Records of the Union and Confederate Armies, Series I, Vol. XLVI, Part III—Correspondence, etc., Richmond Campaign, etc., Serial No. 97, contains a very interesting series of letters relevant to the Tredegar Foundry.

Under date of April 23, 1865, Washington, D. C., Brig. Gen. A. B. Dyer, Chief of Ordnance, wrote Major General Halleck, Commanding, as follows:

"As requested by you, an Ordnance officer will be sent to take charge of the Tredegar Foundry. Captain Shunk, now at Richmond, has been directed to consult with you and to take charge of the foundry until the arrival of the officer."

On April 24, 1865, Richmond, Va., H. W. Halleck, Major General, Commanding, replied:

"I think the Tredegar Works should be put in operation to repair all ordnance here before it is removed North. This will give employment to mechanics whose families we must otherwise feed to prevent starvation."

D. W. Flagler, Bvt. Lt. Col. U. S. Army, Captain of Ordnance, was detailed by Brig. Gen. Dyer to make the inspection supra.

April 29, 1865, Richmond, Va., Captain Flagler rendered his report to Bvt. Brig. Gen. J. C. Kelton, Asst. Adjt. Gen., Military Division of the James, Richmond, Va.:

"General: I inclose herewith a copy of my report to the Chief of Ordnance of the condition of the Tredegar Iron Works. Referring to a conversation I had with the commanding general in regard to the works, I have to say that there is no shop at the works for the repair of arms or suitable for that purpose. I do not think the Ordnance Department could put the works in operation at present, consistently with the wants of the department and economy to the Government.

I have the honor to be, general, very respectfully, your obedient servant.

D. W. Flagler,
Captain of Ordnance.

(*Inclosure*) Richmond, Va., April 28, 1865.

Brig. Gen. A. B. Dyer,
Chief of Ordnance, U. S. Army, Washington, D. C.:

General: In accordance with instructions contained in your orders of the 23rd instant, I have the honor to report that I left Washington on the 24th instant, and arrived in this city on the 26th. I have visited and carefully inspected the Tredegar Iron Works, and find them in nearly the same condition as when work was stopped there on the Saturday previous to the evacuation of the city by the Confederate forces. A sufficient guard is stationed at the works to protect them. The explosion of an arsenal building in the burnt district near the works destroyed the greater part of the windows and injured the roofs of the buildings. The carpenter shop and some other buildings that were destroyed by fire in 1863 have never been rebuilt.

List of Buildings.—The buildings at present consist of one rolling-mill, with smith's shop for repairs attached; a spike shop

for making railroad spikes, rivets, and cut-nails; a shed closed in and used as a carpenter's and pattern shop, three foundry buildings, two machine shops, two blacksmiths' shops, one boiler shop, and an office. There are no storehouses of any kind.

Condition of the shops and machinery.—Generally the shops, mills, and machinery are in as good running order as when the works were stopped. But as all the shops have, for the last few years, been pushed to their fullest capacity, and the supply of the finer machinery, which was formerly purchased from Northern manufactories, cut off, very few repairs have been made. Some new machines have been made at the works, but they are not of the best pattern and workmanship. The lathes and machinery are much worn and would require repairs before nice work could be done. The leather belting in all the shops is so much worn that new would soon have to be substituted. All the furnaces require new fire-brick.

Rolling-mill.—The rolling mill, ten puddling furnaces, one rotary squeezer, one puddle train of rolls, one roll-lathe, five heating furnaces, two trains of bar and sheet rolls, one trip-hammer, two punches, two shears, and a small smith's shop for repairs. Except the furnaces this mill seems to be in better order than any of the other shops. Some of the furnaces are out of order and all require new fire-brick. There are at this mill about thirty tons of assorted commercial bar-iron, the most of it tire, bolt, and nail iron. It was manufactured at the mill. . . .

Foundries.—The largest foundry building (for casting guns) has two air furnaces admitting a charge of 40,000 pounds each, two drying ovens, two cranes, and three pits. The latter are at present about two-thirds full of water. Except the want of fire-brick for the furnaces and the water in the gun-pits this building is in good condition. There is one other small foundry building for casting guns. It has one air furnace admitting a charge of 25,000 pounds, two drying ovens, two cranes and two pits. One of the pits is nearly destroyed and has been used for other purposes. There is one foundry building used for the manufacture of projectiles, railroad-car castings, and general work. It has two cupolas which melt 25,000 pounds of metal each per diem, and one air furnace (not in use) for melting brass. About 300 shell-flasks of assorted sizes, flasks for car wheels, and an assortment of flasks for other work are on hand.

Machine-shops.—There are two machine-shops or turning mills, connected with lathes and machinery for turning and boring guns, and for other heavy work. There are in them twelve turning and boring lathes suitable for 10-inch guns, one large lathe for 15-inch guns, one trunnion-lathe, and six old turning and boring lathes. These last are of very old pattern and could not be used economically. There are also two engine and machinery lathes, one drilling machine, two lathes expressly for railroad axles, and two large unfinished lathes for making steamship engines. Upstairs is a machine-shop for small work, containing fifteen turning lathes, four drilling machines, two planing-machines, and one sear-cutting machine. Outside the building is a vertical turning-lathe which has been used for boring cylinders for steamship engines. This machinery is generally much worn. . . .

Unfinished stock on hand.—There are a few unfinished guns on hand, but all of models not made by the U. S. Ordnance Department. There are two 12-inch smooth-bore guns cast and the boring nearly completed. Guns of this and other large calibers have not been turned on the exterior surface, except at the trunnions and near the muzzle. The exterior surface and form are left as when cast. There are three small guns, supposed to be light 12-pounders, still in the molds in the pits, and five light 12-pounders cast, and one cast and bored and turned except the trunnions. These last are smooth-bore cast-iron guns, with a wrought-iron reënforce, and made to fit the 12-pounder field carriage. There are three unfinished rifled field guns, 2.9-inch bore of the Parrott pattern, but much heavier than the old Parrott 10-pounder, weighing each 1,500 pounds. There are two old model sea-coast mortars, one cast, and one cast and bored, and one 8-inch sea-coast mortar, old model, cast and bored, and three 24-pounder iron field howitzers nearly completed. There are also a few finished guns of various models about the works, but none of them of models made by the U. S. Ordnance Department. These will be taken in charge by the officer collecting ordnance. There are among them some Brooke banded and rifled iron navy guns; three of 6.4-inch caliber, one of 8-inch, and one of 7-inch.

Iron used in the manufacture of guns.—None of the guns in an unfinished state are made from the Cloverdale glaze iron formerly used as gun iron at these works. The supply of Cloverdale iron has been cut off for some time by the U. S. troops. The guns were cast from an inferior Liberty iron from furnaces in Shenandoah County, Va. There are no records of its tensile strength, density, or other qualities, and I do not think any have been taken. Aside from the character of the iron, the appearance of the castings which I examined would, I think, cause them to be rejected on inspection. There are no unfinished projectiles on hand.

Cost of manufacture.—The transportation of coal and iron from the North would make the cost of material for guns considerably greater here than at the Northern foundries. Owing to the unsettled state of labor and society here, it is difficult to estimate the cost of manufacture, even approximately. The cost in the Southern States was greater than in the North before the war, and the high prices which must continue here for some time would make the difference still more. The cost of finishing the guns which have been commenced would be very small, but, being of models different from those used by our army, they would be of little use, except as trophies, and owing to the inferior quality of gun-iron from which they are made their endurance is doubtful. There is no other unfinished work on hand that could be of use to the Ordnance Department. Before the furnaces could be used it would be necessary to rebrick them, and fire-bricks for that purpose would have to be brought from the North. The fire-bricks which were used here, after the supply on hand at the beginning of the war was exhausted, were made from an inferior clay and could only endure the fire for about three days.

Recommendations.—For reasons which have been explained in this report, I do not deem it advisable or economical to the Government to put these works in operation. No ordnance stores could be manufactured here with which the department is not well supplied, and with some of them overstocked, owing to the sudden stoppage of expenditures in the armies. There are no shops at the works for the repairs of arms. All the drawings belonging to the works have been either destroyed or carried off. I would respectfully recommend that the ordnance and ordnance stores at the works be taken away by the officer in charge of captured ordnance property; that they be sent to such points as you may direct, and that the works be left in charge of military authorities here until the Government decides what disposition is to be made of them. If they are not put in operation by private parties, some of the machinery might be moved to Government shops elsewhere. With the exception of the gun foundries, the works are well adapted to the manufacture of iron and iron parts for the repair of railroads, cars, agricultural implements, and machines, and for general iron work.

I am, general, very respectfully, your obedient servant,

D. W. FLAGLER, *Captain of Ordnance.*"

The above report, is of special interest to the many ordnance officers, who have served at Rock Island Arsenal, as the metal foundries, smith shops, etc., there were planned and developed by General Flagler, during his long tour of duty as Commanding Officer of the Arsenal, after the Civil War.

J. W. SLATTERY,
Edgewood Arsenal, Md. *Captain, Ordnance Department.*

Ordnance Field Service

Ammunition Supply, Part II

By Lieut. Col. Raymond Marsh, *Ord. Dept., U. S. Army**

From a survey of this ammunition supply service, as organized, set up, and operated, certain salient characteristics stand out. First, ammunition supply is separated into the two categories of artillery and small-arms ammunition. Secondly, the Field Artillery, a combat element, an arm, is made responsible for the supply of its most essential item, namely, its ammunition. Thirdly, in the division, the responsibility for an adequate ammunition supply is divided among the field artillery brigade commander, the division quartermaster, and the division ordnance officer. Fourthly, the ammunition loads in the service trains are based on days of fire. Fifthly, there are multiple channels of communication for the reports of expenditures, allocation of ammunition, and information related thereto. And sixthly, throughout the entire system there is a strange division of control and command and a most unmilitary and unsound separation of responsibility and authority.

Let us analyze these several salient features. It is becoming increasingly difficult to consider the supply of ammunition from the viewpoint of the two classifications of small-arms ammunition and artillery ammunition. At the present time, infantry fights quite as much by fire power as does the artillery. Its fighting by movement is now more or less limited to movements of occupation of terrain, after the enemy has been driven from this terrain by superiority of fire. And this superiority of fire may consist quite as much of machine-gun and automatic small-caliber fire as of artillery fire. Consequently, the supply of ammunition is of as much importance to an infantry organization as to any other organization. The practicability of dividing ammunition supply into these two categories is very materially complicated by the fact that all combat elements now have requirements for the same type of ammunition, notably, machine-gun ammunition of all calibers. The tanks use cannon ammunition. The antiaircraft artillery use caliber .30 and caliber .50 ammunition and also cannon ammunition. The infantry use trench-mortar ammunition, and there is at the present time a movement on foot to organize in the field artillery, mortar platoons which will use this same kind of ammunition. As the supply of ammunition for all types and calibers of weapons becomes more and more complicated, and the requirements become more uniformly distributed throughout all combat elements, it is apparent that sometime, and perhaps in the very near future, the time-honored division of ammunition into the two classes of small-arms ammunition and artillery ammunition must inevitably break down.

The question of ammunition supply in the division must, it is felt, be examined from the viewpoint of the division commander. He is the one who is responsible for the operations of the division. He is the one who receives the glory if the operations are successful and he is the one who receives the blame if the operations are not successful. At the present time this division commander, with all his responsibilities and all his capabilities for medals or courts martial, must look to his artillery brigade commander, his ordnance officer, and his quartermaster for an adequate supply of that on which the success of his division depends, namely, ammunition. Certainly the responsibilities of a division commander are such that he should not be compelled to have to coördinate the activities of three staff officers for the accomplishment of one service, namely, an adequate ammunition supply service.

When we consider that one of the fundamentals of supply is that the impetus shall be from rear to front, it is strange to see in this ammunition supply service the doctrine established that the field artillery, one of the arms of the army, shall be responsible for its supply of ammunition. However, the doctrine that the supply of ammunition is a function of command is a principle to which the field artillery has long given adherence and support. This doctrine is supported by the provision contained for years past in our Field Service regulations, to the effect that the organization and operation of an ammunition supply service is a function of the artillery. It is partially supported by the fact that the reserve of artillery ammunition is the real artillery reserve. This field artillery doctrine and Field Service principle were embodied in the A.E.F. ammunition supply memorandum of April 1, 1918, which I mentioned, and were repeated in part in the report of the A.E.F. Superior Board on Organization and Tactics, to which I have referred. But thus far this doctrine and principle have been maintained in theory and organization only, and not in practice. It is a matter of record that in the A.E.F., some divisions handled their ammunition supply through the appropriate section of the Division General Staff. It appears that this method operated quite as satisfactorily as the method wherein the field artillery brigade commander exercised those same supply functions. In other words, the A.E.F. experience did not prove that the field artillery doctrine and Field Service Regulation principle constitute the only basis on which an efficient and effective ammunition supply service can be founded. Further, it did not prove that an ammunition supply service founded on any other basis was inherently unsatisfactory. It is true, generally, that the real artillery reserve is the reserve of artillery ammunition. But it is also true that reserves, except local reserves, are held under the control of the division commander. There appears to be no reason why an exception should be made in the case of field artillery. Local reserves of artillery ammunition are provided in the loads of the combat trains of the artillery battalions. These trains constitute the chief means by which flexibility in ammunition supply in advance of the distributing points may be obtained. The artillery brigade ammunition train is not a combat train. It is a service train and is classed as such in the current edition of the Staff Officers' Field Manual. As a service train it is controlled largely in its movements by G-4. Under these circumstances, the artillery brigade commander's control over the train is not absolute and complete, but very decidedly more or less limited. If the function of the artillery brigade ammunition train in battle were to remain parked somewhere in the near vicinity of the artillery positions, so that portions of it could, with a minimum of delay, be ordered by the artillery commander to one battery position or another, then perhaps its place in our organization scheme under artillery command and control would be justified. As a matter of fact, however, when the division goes into battle formation and the artillery goes into position, the artillery ammunition train dumps its load at the artillery ammunition distributing points, and then proceeds to the rear to be reloaded. During its trips from the ammunition distributing points to the refilling points and back, the artillery brigade commander practically has no control over its movements. This means, then, that the only means by which the artillery brigade commander can utilize or control his ammunition reserve are the combat trains of his battalions. Under these conditions there appears to be little difference, then, whether the brigade ammunition train is under the control of the artillery

*This discussion presents the personal views of the author and does not represent any official policy on the subject.

or one of the supply services. From a purely field artillery viewpoint, it would probably be highly desirable for that arm to be so organized as to be completely self-contained and sufficient in itself to meet all requirements and discharge all of its functions. But in addition to ammunition, the successful operations of field artillery depend also upon personnel and prime movers, either animal or automotive, and weapons. But to date I know of no attempt to set up a special field artillery replacement system for personnel, or to organize a special field artillery remount service, or create a special field artillery procurement service for weapons. It must be remembered, however, that combat is not waged by the artillery alone. Combat is waged by the combined arms grouped in combat teams, and the biggest combat team of the army is the division. The division is the unit on which army organization is based and, as I have said before, the Commanding General thereof is the one who is held responsible for results. And may I repeat that his responsibility is such that his organization should be such that he can look to one individual for the efficient, effective and adequate operation of his ammunition supply service.

EXPRESSING the loads of service trains in terms of days of fire is open to criticism. This day of fire is not a fixed unit but is described by the War Department as being a unit which is announced by the War Department at the beginning of each war or major campaign thereof, and may be changed from time to time based upon a consideration of current or contemplated military operations. This means, then, that a fixed military unit may carry in its organic transportation varying numbers of days of fire of ammunition. It would be preferable, it is believed, to establish the loads of ammunition of the service trains upon some relation based upon the capacity of the combat units to carry or absorb ammunition, rather than upon an arbitrary estimated consumption of ammunition which was reached as a result of our experiences in France, with all the special conditions and circumstances under which, in the last two years of the war, combat was carried on.

It is apparent, from the charts showing the channels of communication for the allocation of ammunition and the routing of ammunition expenditure reports, that requirements are set up for multiple channels of communication. In the case of small-arms ammunition, you have a duplicate channel of communication, but in general these channels follow the channels of supply and control of Class IV supplies. In the case of artillery ammunition, however, these channels of communication follow command channels and the corps chief of artillery becomes an important administrative and supply officer in the channels of supply for field artillery ammunition. The imposing of such functions on a corps staff officer is contrary to the official concept and description of an army corps. It is provided in this description that a corps is primarily a unit of execution and maneuver and that, except when operating independently, it has administrative and supply functions for its own corps troops only.

It will be recalled that in one part of the present Staff Officers' Field Manual, it limits the functions of the unit Ordnance officer in the supply of ammunition only as far forward as the refilling points. In another place of the same manual it is provided that the supply of small-arms ammunition is a function of the Ordnance officer. This contradiction, of course, should first of all be eliminated. But assuming that it is the function of the Ordnance officer of a division to supply small-arms ammunition, a study of the method now prescribed reveals the fact that while the Ordnance officer bears the responsibility, he has absolutely no means or facilities under his control to meet that responsibility. In the division, small-arms ammunition is transported in a section of the trains of the quartermaster regiments of the division. It is provided that the quartermaster, upon the request of the Ordnance officer, shall transport such quantities of small-arms ammunition from such refilling points and to such destinations as the Ordnance officer may request. A comparable condition exists in both the corps and the army organization, with the Ordnance officer bearing responsibility but with absolutely no control or authority over the facilities which must be employed to discharge that responsibility, except for his technical control over the ammunition companies in the army and corps. These companies, it must be remembered, provide only the administrative and supervisory personnel for such ammunition installations as may be set up. The labor and transportation required in the operation of all ammunition installations in advance of the army ammunition depots are provided by the quartermaster corps. In the infantry division, the ammunition distributing points can be operated under present organization and regulations only by personnel supplied by the quartermaster from his service troops. This means that the ammunition distributing points, with all the requirements for complete and highly specialized technical information with reference to ammunition, must be operated by troops whose training does not necessarily involve instructions in ammunition matters. It is evident, therefore, that in the ammunition supply service, from the army ammunition depots forward, there is a separation of authority and control from responsibility. This is fundamentally unsound and when considered from the viewpoint of the fundamentals of military organization, is certainly an unmilitary situation.

HAVING pointed out certain facts and characteristics which can be considered only as criticisms and faults of the existing system, it is only fair to submit now means and methods whereby these criticisms may be eliminated and the faults corrected.

The first recommendations submitted by the Ordnance Department, looking to the establishment of a unified, coördinated ammunition supply service, were the recommendations submitted by the Chief Ordnance Officer of the A.E.F. to the A.E.F. Superior Board on Organization and Tactics. I have previously listed the conclusions of the Chief Ordnance Officer. On his recommendations and conclusions the A.E.F. Superior Board commented as follows:

"Recently it has been proposed that the Ordnance Department should man all dumps and ammunition trains and, acting under G-4, should take over the question of ammunition supply.

"On the face of it this proposition looks promising. It fits into the existing diagrammatic scheme of supply and should apparently relieve the artillery of an onerous burden, leaving it free to look only to the front and fight the guns. But closer examination brings up the question whether such a plan is the best for meeting the conditions of actual combat, and whether the responsibility for ammunition supply can properly be shifted completely to G-4 and the Ordnance Department.

"If the Ordnance Department could have actually in being at the beginning of a war the trained personnel complete for manning dumps and ammunition trains, and if this personnel under its own officers could work in the field with troops and thus acquire practice and experience in field conditions, the proposition would undoubtedly have a great deal in its favor. But undoubtedly we will not be able to maintain such organization in time of peace. All that we can hope for is a skeleton organization which can be expanded quickly on the outbreak of war. If this skeleton organization is to be valuable to work with troops it should be with the troops in time of peace so as to gain experience under field conditions; and if this condition is fulfilled it would be better to have them pertain to the troops which they will serve, on the general principle that loyalty should be toward the immediate commander and not toward some distant authority. It is obvious that the Ordnance personnel existing at the beginning of a war will all be required to carry on the work of construction and manufacture. We would seem more liable to be able to form our ammunition supply units quickly if we attached in peace time to our larger units of

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artillery a small skeleton personnel, charged with the study and practice of the problem of ammunition supply, and capable of quickly instructing the great numbers of recruits brought in on the outbreak of war to afford the necessary expansion.

"But there is another and far larger question involved. Ammunition supply in the forward areas is not carried on as per a diagrammatic scheme. The requirements of ammunition must be foreseen and the resources, both of ammunition and of transportation, must be adapted quickly to meet rapidly changing conditions. The chain of responsibility ought to be continuous. The men who serve the forward dumps and those who man corps and divisional ammunition truck trains and regimental combat trains should be involved in the success or failure of the guns, and they should be responsible to the commanders of these guns. Ammunition is a vital concern to the artillery. Without it the guns are idle, and artillery commanders must inevitably carry a large part of the responsibility of seeing that the guns are kept active. They must give quick decisions during combat as to the distribution of available ammunition and get prompt action thereon. To get the ammunition up is just as much the function of the artillery as it is to get the guns up. It is a function of command. To introduce the Ordnance Department into the scheme of ammunition supply at the front is merely to introduce an additional agency charged with a portion of the work to be done. Responsibility, instead of being single, would be divided between the Artillery and the Ordnance.

"For the foregoing reasons it is not thought desirable to introduce the Ordnance Department as an active agent in the distribution of ammunition in the forward areas.

"It is believed that responsibility for ammunition supply should remain with the artillery. But it is very important:

"(a) To prepare at once a manual of ammunition supply showing the organization needed and the duties involved.

"(b) To make ammunition supply one of the essential subjects of artillery training, to be taught at our schools and practiced on the training grounds and at maneuvers.

"(c) To have a skeleton organization for ammunition supply for each artillery command from battalion to the army, comprising a few permanent officers and noncommissioned officers specially instructed in the care, handling and movement of ammunition and the layout of dumps. If our military policy involves a reserve system, then reservists should be listed in sufficient numbers to make up the full quota of each ammunition supply unit.

"At each artillery headquarters, from the battalion up to headquarters army artillery, there must be an ammunition officer with the necessary clerks; for each battalion there must be a combat train; and for each division, corps and army there must be dump and transportation personnel and the necessary ammunition trains."

SINCE the Superior Board phrased this portion of their report, changes have occurred in the War Department which make some of their statements incorrect, and their deductions based thereon consequently erroneous. At the time their report was compiled, the Field Service of the Ordnance Department was not in existence. An Ordnance Field Service "for the supply and maintenance of such matériel as is or may be allotted to the Ordnance Department" was initially established by a War Department Order in 1919. The provisions of this order were modified by a series of War Department General Orders extending over the next five years. In 1924, A.R. 45-30 set up the Ordnance Field Service in its present status, and defined that service as being "that branch of the Ordnance Department charged with the supply, the maintenance in service and in storage, and the alteration and inspection of such matériel as is or may be allotted to the Ordnance Department for storage and

issue." By an Ordnance Department order, the Field Service functions are "the storage, sale, issue, maintenance, surveillance, preservation, inspection and general supervision of all supplies and equipment required by, or retained for, the use of the components of the Army of the United States, its auxiliaries and agencies; . . . . the transfer of Ordnance supplies to other supply arms and services of the War Department; the operation of necessary facilities and depots authorized and assigned for these purposes." The Field Service personnel consists of Ordnance officers of corps areas, departments, divisions, expeditionary forces, coast defenses, camps, posts, and stations, with their military assistants, whether members of the Ordnance Department or not, together with the civilian and enlisted forces authorized and provided; all Ordnance organizations which may have been or may be formed for the supply and maintenance of Ordnance property; all Ordnance personnel attached to or detailed with the arms and/or other service organizations; and Ordnance personnel under the control of the Chief of Field Service at all Ordnance establishments and in general and area depots. The Field Service facilities consist of 18 depots (Ordnance), 5 Ordnance sections, general depots, 1 Ordnance section, area general depot, and 2 area branch depots. The Field Service troop units include 17 maintenance companies, 5 ammunition companies, 6 depot companies, 1 training company, and 1 proving ground company. From this it will be seen that the Ordnance Department does provide a nucleus of trained personnel for manning dumps and ammunition trains. The maintenance companies under Ordnance officers do work in the field with troops and thus acquire practice and experience in field conditions. The Ordnance Department does maintain in time of peace with troops on the several posts, camps, and stations, small units which discharge all functions of ammunition supply, which units provide a skeleton organization in ammunition supply which can rapidly be expanded upon the outbreak of war. It is now incorrect that, as the Superior Board stated, "It is obvious that the Ordnance personnel existing at the beginning of a war will all be required to carry on the work of construction and manufacture". As a matter of fact, through the development of the Ordnance Procurement District system, it is contemplated that the bulk of war-time Ordnance procurement work will be done by reserve officers and specially selected civilians who have been trained in time of peace in these procurement districts. Approximately one-half of the officers in the regular establishment of the Ordnance Department will serve in the field with troops. And generally speaking, no enlisted personnel of the Ordnance Department will be employed in the operation of Ordnance Zone of the Interior installations. I might add that of the three "very important" conclusions of the Superior Board, not a single one of them have been put into effect.

On many occasions since the report of the Superior Board was submitted, officers of the Ordnance Department have made numerous studies under varying conditions and have pointed out the lack of logic, the division of responsibility, and the absence of unity of control in ammunition supply in the theater of operations. Their recommendations have universally involved a reorganization of the ammunition supply service of the division and larger tactical units. These recommendations have all pointed to the consolidation of the ammunition supply service into one organization, organized, operated, manned, and maintained by the Ordnance Department. They have agreed that the Ordnance Department should be charged with full responsibility for and complete control over ammunition supply from the earliest phases of procurement down to and including initial issues and deliveries to troops at distributing points. (*To be continued.*)

INDEX TO ARMY ORDNANCE, VOLUME XVI

The May-June, 1936, issue concluded the sixteenth volume of this Journal. An index arranged by subject and author, with title page for binding, is now available. Copies will be furnished upon request to the Editorial Offices.

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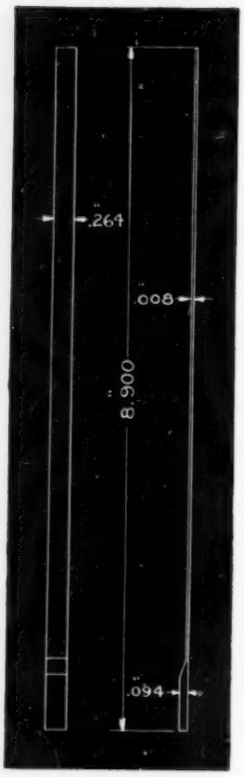

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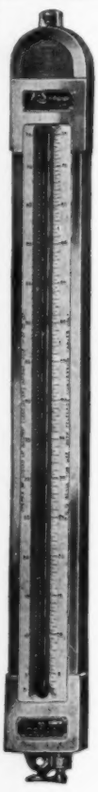

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AOA Chronicle

THE National Advisory Committee for Aëronautics has requested an increased appropriation of $1,367,000 to be spent on the experimental laboratories and the world's largest wind tunnels at Langley Field, Va. It is felt that the present research facilities have ceased to meet the needs of aviation and that some foreign nations will soon surpass the United States in air development if our research facilities are not increased.

The buried shorelines of over one hundred ancient seas which once covered parts of what is now the United States may prove to be a new and unexpected source of petroleum. The method of mapping these shorelines originated at the University of Tulsa and was described recently at the International Petroleum Exposition. The new maps indicate untold oil reserves within the present two-mile drilling limit and more as far as five miles down.

Dr. Reinhold Niebuhr, speaking in Baltimore at a rally sponsored by the committee of the Emergency Peace Campaign, said that we shall be forced into the next war, not by the greed of business men, but by the greed of millions of individuals in all walks of life. Dr. Niebuhr, an editor and professor at the Union Theological Seminary, also stated that to maintain neutrality the cost of taxation must be greatly increased. The Peace Campaign, sponsored by the Society of Friends, is holding meetings in 300 cities in the United States.

Professor Parker T. Moon of Columbia University, editor of *Political Science Quarterly* and author of history textbooks, in an address before the third general session of the National Conference of Social Work, spoke of the American neutrality legislation as a flimsy defense against war and stated that another great conflict would undoubtedly offer the greatest opportunity for Communist or Fascist revolutions—even in the countries that remain neutral. He counseled United States coöperation with League of Nations sanctions as the most useful method of keeping peace.

BERNARD M. BARUCH, chairman of the War Industries Board under President Wilson, in an article in the June issue of *Current History*, brands economic sanctions as hostile acts that probably would bring war. Any serious constriction on a nation's sources of supply, he said, is as dangerous to it as a hostile army, hence the present talk of economic sanctions is an expedient "more dangerous than its proponents realize". For, he argues, any serious constriction by a neutral of a belligerent's channel of civilian supply is as deadly as a declaration of war. Most of the danger of complications with other nations will be removed he says, "if we refuse loans or credits to belligerents, abjure the sale of lethal weapons, require all sales to belligerents to be c. i. f. our ports and withdraw the protection of the flag from shipments and passage on belligerent vessels."

A total of 131 persons and companies engaged in the manufacture, export or import of arms, ammunition and implements of war have registered with the Secretary of State as required by the Neutrality Act. Among the more recent organizations to register was the Ford Motor Company of Dearborn, Mich. In addition to armaments, commercial airplanes also fall within the scope of the statute.

Maj. Gen. Charles E. Kilbourne has been assigned to the command of the Sixth Corps Area to fill the vacancy caused by the retirement of Maj. Gen. Johnson Hagood. General Kilbourne was formerly in command of the 2nd Division at San Antonio,

Texas. Born in Virginia in 1872, he was graduated from the Virginia Military Institute in 1894. He entered the Army as a second lieutenant in 1898 and served in the Philippines in the same year and in the China Relief Expedition in 1900. During the World War he served on the British and French fronts and with the 89th U. S. Division; later he was commander of the 36th Heavy Artillery Brigade and the 3rd Infantry Brigade. He also headed an American mission which inspected the coast defenses of European States and Turkey after the Armistice. General Kilbourne is a graduate of the Artillery School and the General Staff College and has been a member of the faculty of the Army War College. He has served several times on the General Staff He has been awarded the following decorations: Congressional Medal of Honor, Distinguished Service Cross, Distinguished Service Medal, French Croix de Guerre, and the Legion of Honor.

SEVENTEEN Army and Navy heroes will be commemorated in a series of ten stamps to be issued this year by the Post Office Department. The following leaders in the defense services will be thus honored: George Washington, Nathaniel Greene, John Paul Jones, John Barry, Andrew Jackson, Winfield Scott, Thomas MacDonough, Stephen Decatur, Ulysses S. Grant, W. T. Sherman, David G. Farragut, David D. Porter, Robert E. Lee, Thomas J. (Stonewall) Jackson, George Dewey, William T. Sampson and Winfield Scott Schley. The first of the series is scheduled to appear early in August.

Harry H. Woodring, Assistant Secretary of War, in a speech to the Ohio State convention of the Reserve Officers' Association said that the defense forces of the nation are stronger than they have ever been in peace time. Our national defense policies, he declared, are based on the principle advocated by George Washington, namely, that preparedness for war is one of the effectual means of keeping peace. However, he continued, for fifteen years the insidious, undermining propaganda of organized minorities has been directed against national preparedness. "It is my firm belief that they do so to poison the impressionistic youthful minds; to mislead them from the path of constitutional democratic government; to destroy their patriotism and religion and thus shatter fundamental American liberty and lay the foundation for tyrannical rule."

The American Iron and Steel Institute has announced that expenditures for research in the steel industry during 1936 will exceed by 6 per cent the expenditures for this purpose in 1929. The 1936 research budget of forty-two companies comprising nearly 90 per cent of the industry's capacity, totals $9,200,000. Approximately 40 per cent of this amount will go toward discovering means of improving quality of products; 20 per cent will be spent in developing new products; 12 per cent in determining where and how these new products can be used best; about 18 per cent will go toward reducing costs; and about 10 per cent toward developing new markets and finding new uses for standard products.

ONE of the greatest difficulties experienced by the tank unit of the Bolivian Army in the recent Chaco War was the extremely high number of casualties caused by splinters or bullets entering the visors which were found to be badly located and inadequately protected. In the first two encounters nearly every man was wounded—the drivers, especially, were wounded about the eyes. Difficulty was also encountered in maintaining personal liaison with the infantry; observation and machine-gun fire while in motion were practically valueless. Moreover, the air-cooled motors and guns proved very unsatisfactory, especially the latter, since they could not be equipped with armored jackets. These facts were brought out in *Militär Wochenblatt* by Wim Brandt, an engineer and major in the Bolivian Army reserve who commanded the tanks in the Chaco.

Col. Richard H. Jordan, Quartermaster Corps, will become Assistant Quartermaster General with the rank of Brigadier General for four years beginning August 1st. He will succeed

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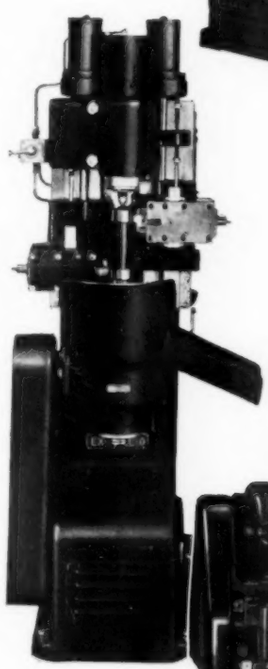

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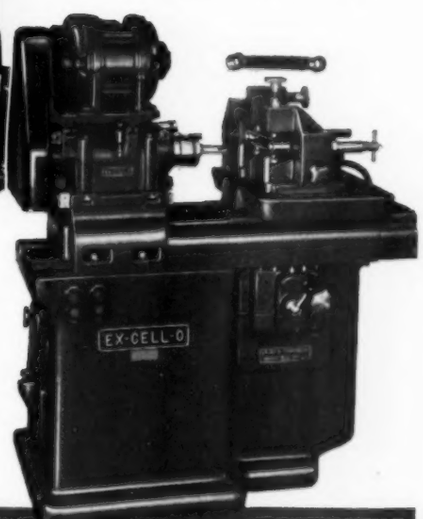

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Brig. Gen. William R. Gibson who will retire from active service on July 31st. Colonel Jordan is at present in charge of the Transportation Division in the Office of the Quartermaster General. A native of Haymarket, Va., he entered the service as a second lieutenant in the Artillery Corps in 1901, serving most of the period before the war with the Coast Artillery. During the World War he served in Washington as executive assistant to Gen. Frank T. Hines in charge of the Embarkation Service. After the Armistice he was assigned to duty with the Peace Commission at Paris. He was awarded the Distinguished Service Medal for his war service.

Britain's Royal Air Force is being increased threefold as compared with 1934 and fifteen hundred more pilots are being trained, it was disclosed by Sir Thomas Inskip, Minister for Defense Coördination in a speech before the House of Commons. Moreover, nine hundred industrial plants have been examined as potential munition factories and a survey has been made of other British technical resources. In the industrial field, automobile manufacturers are being relied upon to build up the reserve capacity of the air force, while motor firms have been requested to build new airplane factories with Government funds.

THE 1936 London Naval Treaty between the United States, Great Britain and France having been ratified by the United States Senate without a dissenting vote, will go into effect next January 1st, automatically becoming the only naval treaty in existence. The new pact permits unlimited building within any given category but prohibits the building of new types. It also provides that complete information regarding plans be exchanged between the signatories and stipulates that four months' notice be given before any new construction, purchase or repair of ships is undertaken. However, if one of the signing powers feels that its national security is endangered, or that building by a nonsignatory necessitates a like activity of its own, notice to the other signatories of this intention is all that is required to make the limitations inoperative. The treaty is to terminate on December 31, 1942. Adm. William H. Standley, American delegate to the treaty conference, testified before the Senate Foreign Relations Committee that the Navy, since 1930, had altered its views about cruiser tonnage and gun power. It is now felt that the 6-inch gun cruiser is to be preferred over the 8-inch gun type for certain specific needs. Admiral Standley showed that the United States did not stand to lose by the 6-year holiday in 8-inch gun cruisers and 10,000-ton 6-inch gun cruisers. He said: "We had the number (of 8-inch gun cruisers) allowed us under the treaty already under way, building, and we did not want to build any more of these during the next six years."

After receiving a favorable report from the Department of Experiment on fifteen helmets tested at Fort Benning, Ga., last summer, the War Department is distributing approximately 1600 composition and 100 cloth-lined straw helmets to various branches for tropical and semitropical wear. Each service board, except the Air Corps, will receive 100 of the composition type with about the same number being sent to the National Guard, which will also receive 50 helmets of the straw type. If the tests prove successful it is probable that this type of headgear will be adopted for regulation wear by all troops, except the Air Corps, stationed in warm climates.

Air transports with a cruising radius of 10,000 miles will be under construction within four years if the prediction of George Strompl, factory superintendent of the Douglas Aircraft Company at Santa Monica, Calif., comes true. He also predicted that six hours will be the flying time between New York and Paris in stratosphere ships to be completed within the next five years.

THE Senate Munitions Investigating Committee, rendering another of its apparently unending reports, referring to the tentative legislation of the War Department's 1933 Industrial Mobilization Plan, held: "The industrial mobilization plan is founded

upon certain general principles. Among them are that victory and its prerequisite, increased production, are the primary object of a nation at war to which all other aims are subsidiary, that any controls undertaken in war should not be so drastic as to cause any change in normal economic conditions, and that a major part of the planning effort should be devoted to effecting a smooth functioning of the procurement machine rather than profit limitation. Starting from these assumptions, the effectiveness of the plan in eliminating the economic evils of war will be limited. In case of a major war the coöperation of labor is very important to the successful functioning of the war machinery. The problem of securing such coöperation without necessarily infringing upon established liberties is a difficult one. Testimony covering the industrial mobilization plan indicates that the War Department expects to secure such coöperaton by laws and rules which are in fact, although not in name, orders to industrial and other labor to either work or fight or starve."

The greater part of the work on Britain's mammoth $75,000,000 naval base at Singapore has been completed. Its main defenses consist of a series of 18-inch guns. The British cannon are said to have a maximum range of fifty miles with an accurate moving-target range of thirty miles. Other modern ordnance, consisting of from 12- to 16-inch guns, has been placed on the islands of Pulau Tekon, Pulau Brani and Blakang Mati. This group, located in the Straits of Johore, form part of the defenses of the Singapore base.

A RECENT list of the Italian losses in the Ethiopian campaign shows that 4359 men lost their lives—2313 being white officers and men, of whom 1148 were killed in combat and 1009 died through illness or other causes. One hundred and twenty-five died as the result of wounds and 31 were unaccounted for. In addition to the Italian soldiers, 1593 native soldiers and 453 white workers lost their lives.

The Senate has passed House Resolution 5730 liberalizing the profit-limitation provision of the Vinson-Trammell shipbuilding act. The measure has been sent to conference for agreement on Senate amendments.

The Rev. George G. Murdock, speaking in St. Patrick's Cathedral, New York, in behalf of the endowment fund of the Catholic Chapel at West Point, of which he is pastor, stressed the need of religious as well as military training for Army and Navy officers. A well-trained and properly financed military he said, is our nation's greatest defense against communism and socialism and its greatest protector both in peace and in war—provided its members are Christian, God-loving and God-fearing men. Unless our future generals are men of such caliber, he continued, some day we may find our armed forces backing irreligious ideas in government as is happening today in Mexico and Russia.

The Senate Finance Committee has approved a bill providing for heavy taxes on personal and corporate income in war time to finance the country's military needs by revenues instead of loans. The bill, approved by the House, provides personal income-tax exemptions up to $800 for single persons and $1600 for married persons. The plan provides for the tax to begin with $40 on an income of $2000 for a married person and to range up to $880,510 for incomes of $1,000,000. The bill also imposes the following graduated corporate income taxes: 15 per cent on those net incomes not in excess of 2 per cent of adjusted declared value; 25 per cent on net incomes not in excess of 6 per cent of adjusted declared value; and 100 per cent on net incomes in excess of 6 per cent of adjusted declared value. The latter portion may be altered to conform with the new revenue bill, action on which is now pending.

Czechoslovakia's Supreme Defense Council, presided over by President Edouard Beneš, has approved the construction of permanent fortifications along the German border. Funds to provide for the cost of construction has already been voted.

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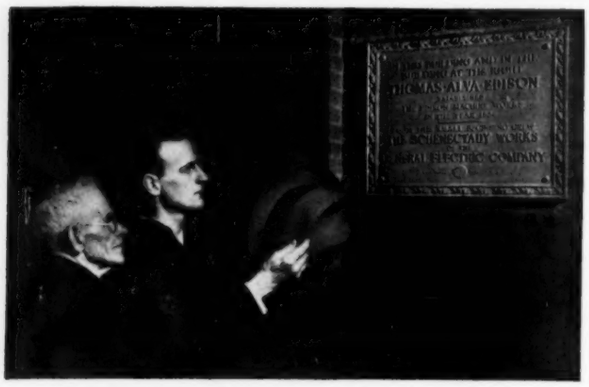

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Book Reviews

A Rebel War Clerk's Diary. By J. B. Jones. New York: Old Hickory Book Shop. 1935.

How can one review a book which is a diary covering four years and which in almost every one of its more than twelve hundred entries contains something interesting, illuminating, vitally human, and typically American? This is the problem that confronts the reviewer of this diary of John Beauchamp Jones, Chief Clerk in the Office of the Secretary of War of the Confederates States of America.

Mr. Jones was born in Baltimore in 1810, spent his boyhood in Kentucky and Missouri, became editor of the Baltimore "Saturday Visitor" in 1841, when his work aroused favorable comment from Edgar Allen Poe, and in that same year published a book on western life which sold 100,000 copies. The next twenty years were spent in writing and editing and when the Civil War broke out he was the editor of a weekly paper in Philadelphia which, although it was pro-South in its attitude, was far from belligerent. His diary tells what he was doing when the expedition against Fort Sumter sailed and from then until the end of April, 1865, there is an entry every day in this diary.

The motive which led to this continuous day-by-day record is expressed by Jones himself under date of April 29th, 1861, when he wrote—"At fifty-one I can hardly follow the pursuit of arms; but I will write and preserve a Diary of the Revolution. . . . To make my Diary full and complete as possible is now my business." From then on, for four years Jones was at the source of information in either Montgomery or Richmond, where he had ample opportunity to know what was going on, learn the views of men high in the affairs of the Confederacy and in his own opinions, reflect the reactions of the man-on-the-street in a belligerent capital to the repercussions of a great war.

Typically American is the entry of April 12, 1861, which says, "The conversation turning upon the deficiency of a supply of improved arms in the South, if a great war should ensue, the Governor (Gov. Wise) said, with one of his inevitable expressions of feeling, that it was not the improved *arm*, but the improved *man* which would win the day. Let brave men advance with flint locks and old fashioned bayonets on the popinjays of the northern cities—advance on, and on, under the fire, reckless of the slain, and he would answer for it with his life, that the Yankees would break and run."

Of the mobbing in Baltimore of the Massachusetts troops he writes, "It was a brick bat Plug Ugly fight—the result of animal and not intellectual or patriotic instincts. Baltimore has better men for the strife than bar-room champions." Of the Secretary of War, he naïvely remarks, "He was a successful lawyer, and having never been in governmental employment, is fast working himself down." The consideration given to military organization initially is indicated by the entry, "A great many separate companies are accepted. . . . What a deal of annoyance and labor it will be to organize these into battalions, regiments, brigades and divisions! And then comes the appointment of staff and field officers." Essentially human is the lament over the hardships his able-bodied sons experience when they are occasionally exposed to stormy weather and asked to drill regularly, despite the fact that Jones frequently voices the opinion that every one should be at the front.

And so one could go on at length citing interesting items of the high cost of living in Richmond during the war, bits of intrigue, amusing credulity, and unconscious exaggeration and bravado. The fog of war and the uncertainty of communications

are strikingly indicated in the entries after the battle of Gettysburg, when for days a victory is envisaged. Or maybe it was well disguised censorship or propaganda!

The military historian will learn little of military value from this book beyond the important consideration of viewpoints and information, or lack of information, at the War Department. But for the student of history it is an answer to that Emersonian plea for more lives of obscure men. The editors and publishers of this two-volume work have rendered a great service in making this record available to the public. R. M.

AMERICAN NEUTRALITY, 1914-1917. By Charles Seymour. New Haven: Yale University Press. 1935. $2.00.

CAN WE BE NEUTRAL? By Allen W. Dulles and Hamilton Fish Armstrong. New York: Published by Harper & Brothers for Council of Foreign Relations, Inc., 1936 $1.50.

BOTH of these books, as their titles indicate, deal with neutrality—that much discussed and little understood term. Both appeared while some of the gentlemen of the United States Senate were in a stew on what, if anything, to do about it. The Senate stewed itself into extending the so-called Neutrality Act of 1935 for another year at the end of which time both volumes should come to the fore again. They are decidedly worth study during the interim.

Professor Seymour is a Sterling professor of history at Yale University. He was a member of the American delegation at Paris, 1919. He is a realist, historian, and the author of many books on international relations. Mr. Dulles, formerly of the State Department, was a member of the American Delegations at the Paris Peace Conference, the International Conference on Arms Traffic, the Three Power Naval Congress and the Disarmament Conference. Mr. Armstrong is the Editor of *Foreign Affairs* and the author of "Europe Between Wars?" "Hitler's Reich", and "The New Balkans." Both books are factual. Professor Seymour is slightly more realistic than Messrs. Dulles and Armstrong.

"American Neutrality" is the story of the boomerang the U-boat campaign of 1916 proved to be for Germany. It is the narrative of how and why the American Congress eventually declared war, April 6, 1917. Some members of that same august body would do well to read the book now. There might then be a slim chance that some crazy notions about neutrality would fade into the thin air from which they are made. Professor Seymour is not at all sure that we can stay out of the next war. He tells why and his reasons are to the point. He is sure no great nation ever met an issue by blinking at it—least of all by fooling itself. He cracks down on our great expert in demonology, Hon. Gerald P. Nye, and shows that delightful but costly speech-maker to be an equally delightful and costly twister of facts.

The author proves to all sane and sincere readers that (a) we were not drawn into the World War by our export of munitions; (b) our intervention was not determined by pressure from financial groups. "Except for the submarine" he writes "our quarrel would have been with the Allies." Automatic embargoes are no way to keep out of war, and legislation designed to isolate us from the rest of the world raises hopes that cannot be fulfilled. But Professor Seymour advocates an equally treacherous method when he concludes that "For our own ultimate salvation we must stand ready to coöperate vigorously with the States whose welfare, like our own, depends on peace."

Messrs. Dulles and Armstrong present a fair-minded critique of neutrality fads and foibles. They too are realistic in their premises. But they seem to see neutrality as a to-be-desired stepping stone to our entry into the League of Nations. Thus they conclude: "The duty to help prevent wars is not primarily one which the United States owes to other nations. It is a duty which we owe to ourselves and which our Government owes to its people. Self interest should determine our course of action.

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Let it be enlightened self interest. Sections of our press and many of our political leaders preach to us that collaboration for peace is dangerous, that it would embroil us in European and Asiatic affairs of no concern to us." This is fine so far as it relates to the foolishness of an embalmed neutrality act wherein all you have to do is flip a switch whenever there is war anywhere and the act comes to life to keep us out of war. But if the authors mean we should be dillying with every hot spot on the globe no matter how remote—then they may mean that right now we ought to be laying down the law as to whether German military forces shall stay in the Rhineland. And if we should say the Germans must vacate and the Germans say "We will not" then what would Messrs. Dulles and Armstrong have us do—this side of force? But force, regardless of kind, means war. So we are right back to the very thing the authors are sincerely trying to have us avoid. L. A. C.

SAWDUST CAESAR. By George Seldes. New York: Harper and Brothers. 1935. $3.00.

LIKE the noble knights of King Arthur's Table Round, American journalists of recent years, wearing the colors of truth and justice, have engaged in quests among the peoples of many lands, probing into the novel politics of strangers, encountering untold numbers of dragons, fair ladies, giants, and caitiff knights, and regaling "the folks at home" with wondrous tales of high adventure. Whether or not the mass of these writings has any influence upon the thoughts of the nation, it is difficult to say, but fervently we may hope that "Sawdust Caesar" will be widely read by our people. It cannot fail to impress them; and the result should be to make them treasure more dearly the basic institutions of our government, the essential good that lies in the historic instruments of civil right and personal liberty that distinguish the political genius of our race.

Since 1918, democracy, for which we went to war so ardently, has been crumbling before our eyes. The whole structure of liberal political development of the nineteenth century, which seemed at last ready for a triumphant housewarming, has collapsed, leaving only the sturdy foundation that existed in the days of our grandfathers. Well may the democracies which still exist regard the scene with uneasiness! In a foreign country, the aspect of one man seizing autocratic power has ceased to excite our wonder, it has occurred too frequently. But pardonable curiosity may sometimes prompt the question: by what means does a dictator gain his ends in this modern world? Mr. Seldes answers this question adequately. The formula was developed in the dawn of history and has been applied *ad nauseam* throughout the political life of mankind.

The book starts with the childhood of Mussolini and follows him through the years to the Ethiopian campaign. In general it is safe to discount freely contemporary works on politicians: who among Lincoln's Illinois associates would have predicted his present position in American history? Caesar's activities probably scandalized all the better people of Rome; Napoleon separated from his grenadiers was not an heroic figure among the politicos. But even allowing for the hostile attitude of a liberal journalist toward a dictator, the simple facts that the author sets forth are worthy of profound consideration. Copious quotations and ample documentation minimize the doubt that naturally arises concerning a book where names of living persons are linked with the most astounding actions. And implicitly there exists in the text a serious indictment of the daily press that has for so long left the people of this country in ignorance of what has been going on in Italy.

Today the world watches with misgivings the march of Il Duce. It is wholly orthodox, and to historians it is a conventional move in the progress of an autocrat. Unfortunately history provides the answer to the question that is in all of our minds. Mankind is in the uncomfortable position of the crystal gazer who sees his own future up to a certain point, after that the picture becomes clouded, and he is left in confusion. J. M. E.

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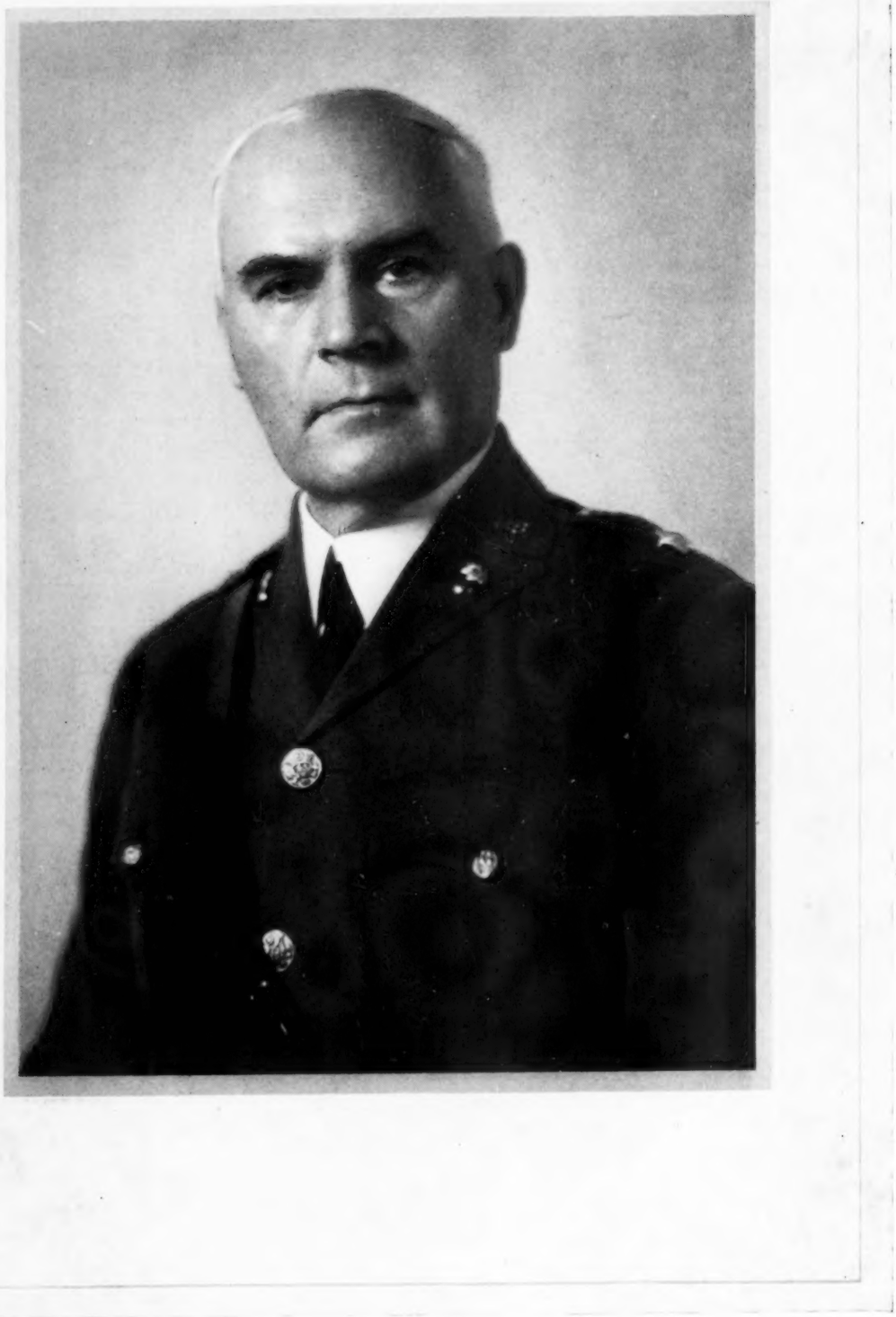

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